ENGINEERING

An Illustrated Weekly Journal

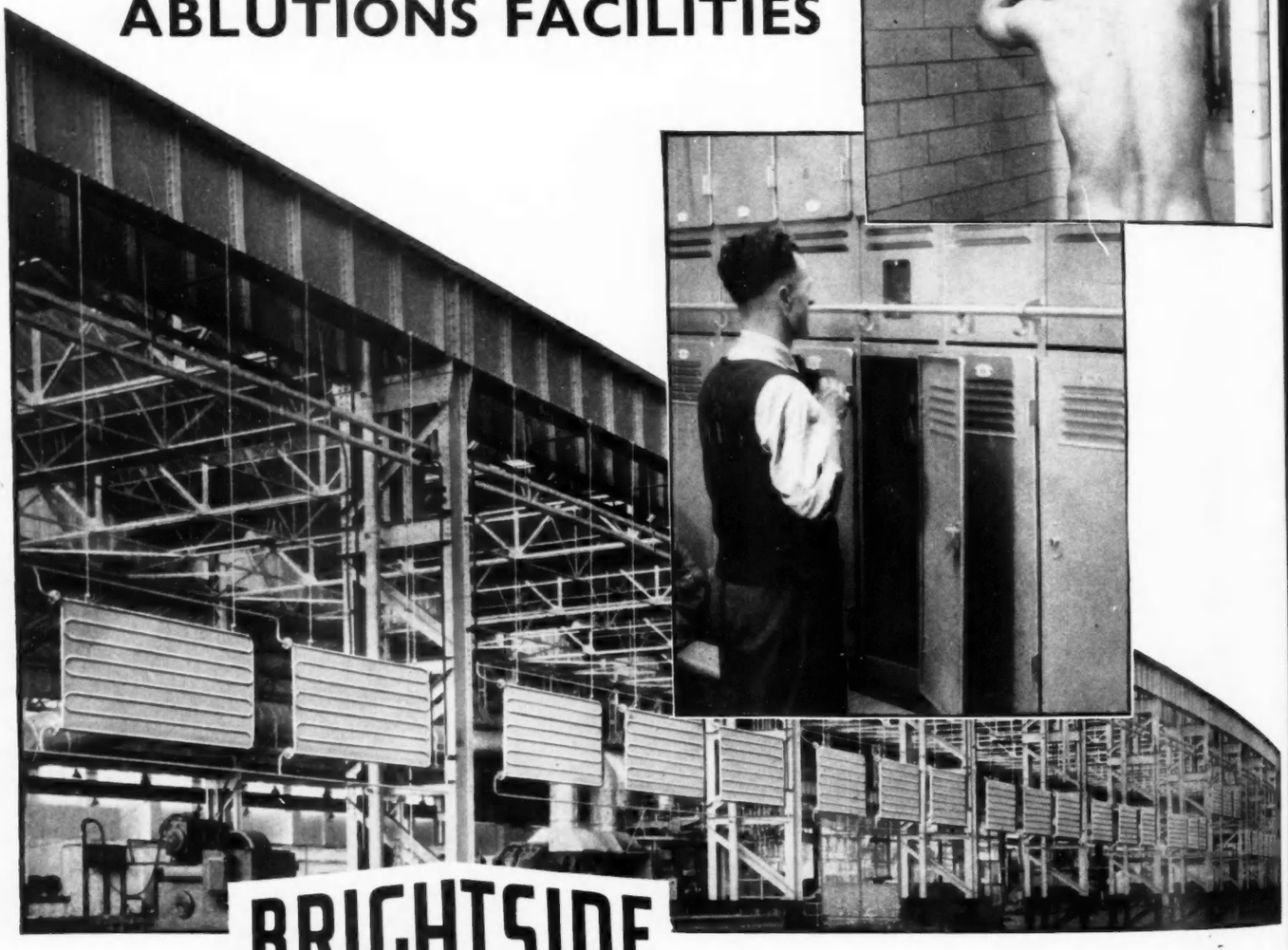
35 & [illegible] BEDFORD STREET, STRAND, LONDON, W.C.2 - - TELEPHONE: TEMPLE BAR 3663

Vol. 181 No. 4[illegible] LONDON, FRIDAY, JANUARY 27, 1956 PRICE 2s.

[illegible] REEL FOR A STRIP MILL

The Iron & Steel Foundries Regulations 1953

HEATING, VENTILATION DUST CONTROL ABLUTIONS FACILITIES



BRIGHTSIDE

Brightside with their own foundries of widely different types and their extensive experience in heating and ventilating are in an unusually authoritative position to advise on the matters of heating, dust control and ablution facilities that are raised by the new Regulations.

It is suggested that you should send for descriptive literature, but better still, you are invited to view actual installations. The " Brightrad " Radiant Panel in the heating field—the layout and working ablutions and lockers in amenity centres—the downward fume exhaust systems on " Knockouts " in the mechanised foundry —each is worth a visit of inspection.

Please write to—

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(A Subsidiary of The Brightside Foundry & Engineering Co. Ltd.)

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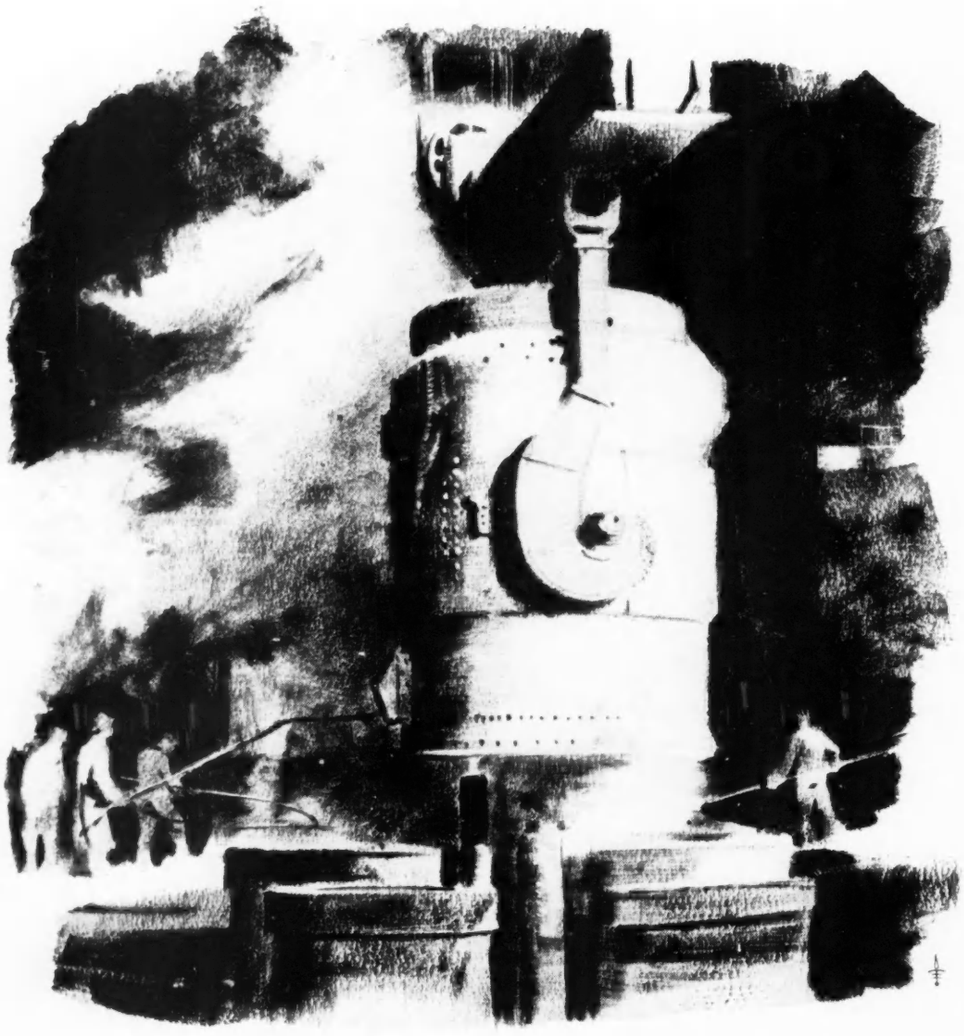

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pig iron, semis, plates and plate products, bar steel, sections, strip, wide flats, permanent way materials, steel pipe, steel tubular products, Sicromal and other specialty steels, clad products By-Products: Ground-basic slag, slag products, especially blast furnace pumicestone slag and powdered blast furnace slag.

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INDEX TO ADVERTISEMENTS

	PAGE
ACE Machinery, Ltd.	00
Aerex, Ltd.	00
Allen, Edgar, & Co., Ltd.	00
Aluminium Union, Ltd.	00
Anderton, W. R., & Co., Ltd.	00
Armstrong Patents Co., Ltd.	11
Arpic Eng'g. Ltd.	78
Ashworth, E. & A., Ltd.	97
Asquith, Wm., Ltd.	00
Asquith, D., & Sons, Ltd.	15
Auld, D., & Sons, Ltd.	00
Automatic Coil Winder & Electrical Equipment Co., Ltd.	102
Barclay, Kellett & Co., Ltd.	97
Begg, Cousland & Co., Ltd.	104
Bigwood, J., & Son, Ltd.	00
Blakeborough, J., & Sons, Ltd.	77
Booth, Joseph, & Bros.	00
Braby, F., & Co., Ltd.	00
Braithwaite & Co., Engineers, Ltd.	00
Brightside Heating & Eng'g. Co., Ltd.	*Wrapper* II
British Electrical Repairs, Ltd.	00
British Oxygen Co., Ltd.	67
British Paints, Ltd.	00
British Steam Specialties, Ltd.	99
British Thermostat Co., Ltd.	00
British Thomson-Houston Co., Ltd.	*Wrapper* VIII
Broom & Wade, Ltd.	00
Brown, David, Corpn. (Sales), Ltd.	00
Bydeberg Gauge Co., Ltd.	103
Butterley Co., Ltd.	*Wrapper* VII
Butters Bros. & Co., Ltd.	68
C. & M. Eng'g. Co., Ltd.	98
Caird & Rayner, Ltd.	00
Carter, B. & F., & Co., Ltd.	00
Chamberlain Industries, Ltd.	00
Chesterfield Tube Co., Ltd.	103
Clarke, Chapman & Co., Ltd.	55
Clayton, Son & Co., Ltd.	00
Clyde Crane & Booth, Ltd.	00
Clyde Crane & Eng'g. Co.	00
Colt Ventilation, Ltd.	00
Compoflex Co., Ltd.	00
Cooper & Co. (B'ham), Ltd.	00
Crane Packing Ltd.	00
Crofts (Engineers), Ltd.	00
Crossley Bros., Ltd.	36
Crosthwaite Furnaces & Scriven Machine Tools, Ltd.	101
Crowthorn Eng'g. Co., Ltd.	00
Dallow Lambert & Co., Ltd.	00
Darwins, Ltd.	00
Dawson & Downie, Ltd.	101
Distington Eng'g. Co., Ltd.	48
Doxford, Wm., & Sons, Ltd.	00
Drummond - Asquith (Sales), Ltd.	00
Dyson, R. A., & Co., Ltd.	97
Edison Swan Electric Co., Ltd.	00
Edwards, F. J., Ltd.	108
Electrothermal Eng'g., Ltd.	10
Empire Eng'g. Co. (Manchester), Ltd.	97
Evershed & Vignoles, Ltd.	9
Evode, Ltd.	00
F. H. (Newcastle), Ltd.	00
Fenner, J. H., & Co., Ltd.	00
Ferodo, Ltd.	00
Ferranti, Ltd.	80
Financial Times	46
Firth-Derihon Stampings, Ltd.	00
Fleming & Ferguson, Ltd.	9
Flexible Ducting, Ltd.	00
Fowler, John, & Co. (Leeds), Ltd.	00
Fox, Samuel & Co., Ltd.	58
Fraser, John, & Son, Ltd.	00
Fraser & Fraser, Ltd.	99
Fullers' Earth Union, Ltd.	00
General Electric Co., Ltd.	99
Glacier Metal Co., Ltd.	*Wrapper* VI
Glenboig Union Fire Clay Co., Ltd.	00
Gordon & Gotch, Ltd.	00
Govan Shafting & Eng'g. Co.	00
Green, R., Ltd.	00
Greenwood's Standard Gear Cutting Co., Ltd.	99
Hackbridge & Hewittic Electric Co., Ltd.	00
Harland Eng'g. Co., Ltd.	00
Harland & Wolff, Ltd.	104
Harvey, G. A., & Co. (London), Ltd.	00
Head, Wrightson & Co., Ltd.	53
Heenan & Froude, Ltd.	00
Herbert, Alfred, Ltd.	10 & 00
Holmes, C. D., & Co., Ltd.	00
Hope, Henry, & Sons, Ltd.	00
Horne Eng'g. Co., Ltd.	9
Hudswell, Clarke & Co., Ltd.	100
Hunt, R., & Co., Ltd.	100
Ilford, Ltd.	00
International Combustion Group of Companies	*Wrapper* III
Jackman, J. W., & Co., Ltd.	14
Kent Alloys, Ltd.	34
Kingsbourne Products, Ltd.	00
Klöckner - Humboldt - Deutz A G.	79
Lafarge Aluminous Cement Co., Ltd.	00
Landen (Engineers), Ltd.	108
Lee, A., & Sons, Ltd.	65
Leeds Eng'g. & Hydraulic Co., Ltd.	00
Leyland Motors, Ltd.	80
Lister, R. A., & Co., Ltd.	101
Lloyd, F. H., & Co., Ltd.	00
Lloyd's Sawmills, Ltd.	00
Lockwood & Carlisle, Ltd.	00
Macdonald, John, & Co. (Pneumatic Tools), Ltd.	00
Madan, C., Ltd.	00
Mannesmann - Export GMBH	33
Mather & Platt, Ltd.	00
Metropolitan - Vickers Electrical Co., Ltd.	57
Midland Iron Co., Ltd.	98
Mills, C. A.	108
Minnesota Mining & Mfng. Co., Ltd.	97
Mitchell Eng'g., Ltd.	*Wrapper* V
Modern Machine Tools, Ltd.	00
Mollart Eng'g. Co., Ltd.	00
Mond Nickel Co., Ltd.	60
Monks & Crane, Ltd.	00
Morris, Herbert, Ltd.	00
Mulberry Co.	108
Murad Developments, Ltd.	101
National Boiler & General Insurance Co., Ltd.	00
National Steel Foundry (1914), Ltd.	00
Nitralloy, Ltd.	00
Norris Bros., Ltd.	108
Opperman Gears, Ltd.	11
Opperman, S. E., Ltd.	00
Osborn, S., & Co., Ltd.	13
Park, Wm., & Co., Forgemasters, Ltd.	00
Peglers, Ltd.	16
Perkins, F., Ltd.	00
Phoenix-Rheinrohr AG.	*Wrapper* IV
Phosphor Bronze Co., Ltd.	35
Plowright Bros., Ltd.	00
Pool, J., & F., Ltd.	00
Prat-Daniel (Stanmore), Ltd.	00
Priest Furnaces, Ltd.	00
Proctor, J., Ltd.	15
Qualters & Smith Bros. Ltd.	14
Quasi-Arc, Ltd.	45
Randalrak, Ltd.	101
Ratcliffe, F. S. (Rochdale)	13
Rawlplug Co., Ltd.	00
Renold Chains, Ltd.	00
Riley, A. J. & Son, Ltd.	104
Research Engineers, Ltd.	2
Riley, Robt., Ltd.	1
Roberts, J. W., Ltd.	16
Robson, Geo., & Co. (Conveyors), Ltd.	9
Rolls-Royce, Ltd.	00
Rosser & Russell, Ltd.	108
Rubery Owen & Co., Ltd.	10
Russell, Geo., & Co., Ltd.	00
Ruston & Hornsby, Ltd.	47
Seagers, Ltd.	99
Shaw, W., & Co., Ltd.	102
Shipbreaking Industries, Ltd.	00
Sigmund Pumps, Ltd.	00
Silentbloc, Ltd.	00
Simm, G. E. (Eng'g.), Ltd.	00
Skefko Ball Bearing Co., Ltd.	56
Slick Brands, Ltd.	00
Small & Parkes, Ltd.	15
Smedley Bros., Ltd.	00
Smith, T., & Sons (Rodley), Ltd.	00
Smith & McLean, Ltd.	11
Soag Machine Tools, Ltd.	108
Spear & Jackson, Ltd.	00
Spencer - Bonecourt - Clarkson, Ltd.	1
Stothert & Pitt, Ltd.	00
Sulzer Bros. (London), Ltd.	54
Superheater Co., Ltd.	100
Tangyes, Ltd.	00
Tattersall & Sons, Ltd.	98
Taylor & Jones, Ltd.	00
Technoexport	59
Templewood Eng'g. Co., Ltd.	00
Terry, Herbert, & Sons, Ltd.	00 & 104
Thompson, J., Motor Pressings, Ltd.	00
Tonks, J., & Co., Ltd.	00
Town, F., & Sons, Ltd.	100
United Kingdom Atomic Energy Authority	14
United Steel Co's Ltd.	58
Vaughan Crane Co., Ltd.	00
Visco Eng'g. Co., Ltd.	102
Vokes Genspring, Ltd.	12
Wailes Dove Bitumastic, Ltd.	00
Ward, Thos. W., Ltd.	108
Wellman Bibby Co., Ltd.	103
Wells, A. C., Co., Ltd.	12
West, A., & Partners, Ltd.	00
West Yorkshire Foundries, Ltd.	00
Westool, Ltd.	00
White, R., & Sons (Engineers), Ltd.	00
Whittle, T., & Sons, Ltd.	12
Wiggin, H., & Co., Ltd.	00
Wigglesworth, Frank, & Co., Ltd.	98
Wiley, James, & Sons, Ltd.	97
Wilkes, A. H., & Co.	13
Wilkins & Mitchell, Ltd.	00
Wilkinson Rubber Linatex, Ltd.	00
Wiseman, Alfred, & Co., Ltd.	00
Wood, E., & Co., Ltd.	00
Worthington-Simpson, Ltd.	00

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Specialists in the design and construction of Steam-Raising Plant, utilising waste gases, in the Gas, Chemical and Ceramic Industries; also the Iron and Steel Industries. Heat-recovery from internal combustion engines and similar prime movers in Land and Marine Installations. A direct method of saving fuel.

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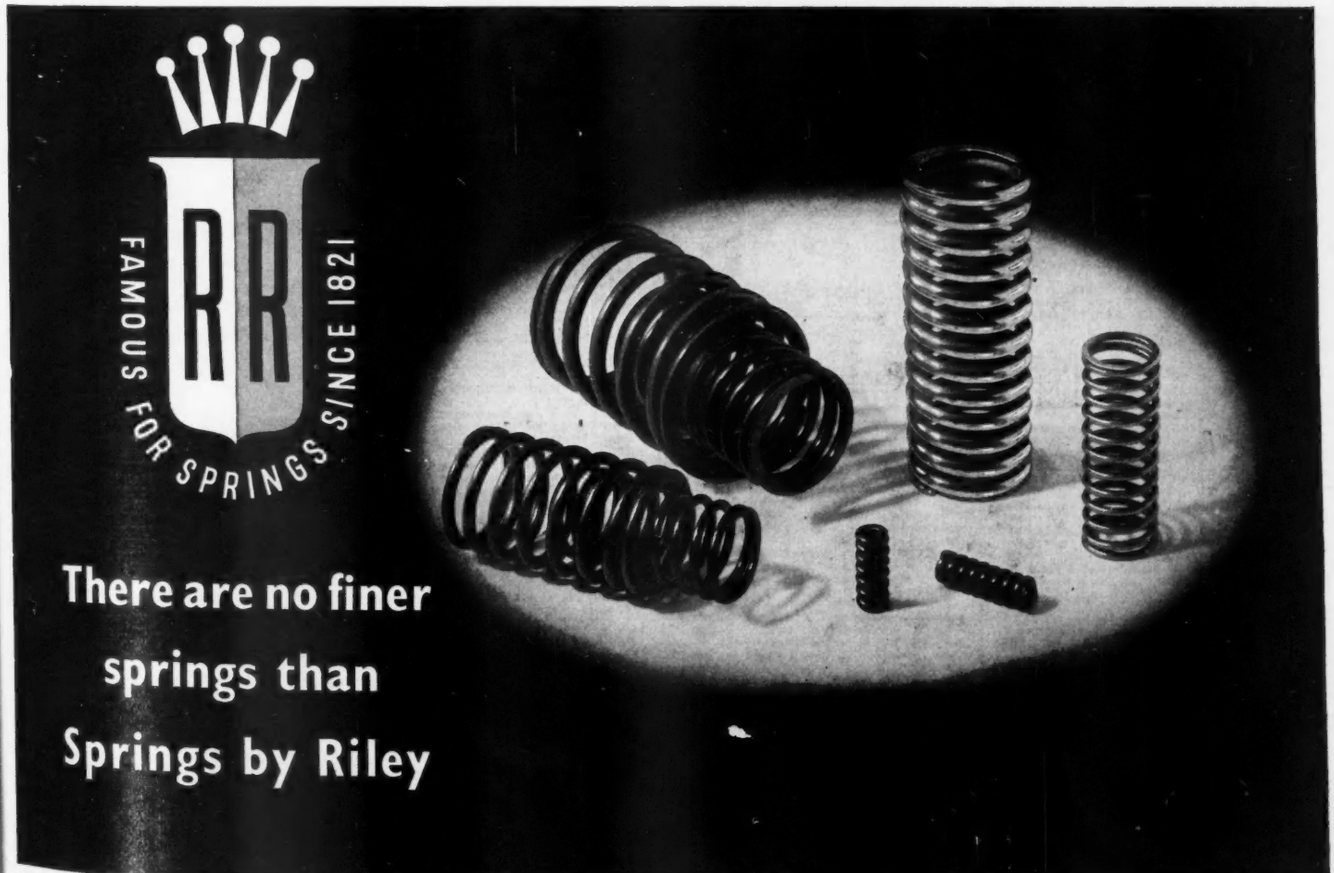

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CLASSIFIED ADVERTISEMENTS SECTION.

For all advertisements classified under the headings of Tenders, Appointments Open, Situations Wanted, Patent Agents, Partnerships, Wanted, &c., Auction Sales, Publications For Sale, Miscellaneous and Public Notices, &c., the charge will be **12s.** for the first four lines or under and **3s.** per line up to one inch. When an advertisement measures an inch or more, the charge will be at the rate of **36s.** per inch. 5% allowed on 6, 10% on 13, 15% on 26 and 20% on 52 Weekly insertions. If use is made of a box number the extra charge is **2s.** per insertion with the exception of advertisements appearing under Situations Wanted. Prospectuses and Notices of Company Meetings **£25** per column. Copy instructions must be in our hands first post Monday for the following Friday's issue. Address to the Manager, ENGINEERING LTD., 35 and 36, Bedford St., Strand, W.C.2. Inclusion of advertisements must be dependent on space being available.

EDUCATIONAL.

FREE. Brochure giving details of courses in Mechanical and Production Engineering, Draughtsmanship, etc., for the A.M.I.Mech.E., A.M.I.P.E., City and Guilds and other Professional examinations. H.M.I. INSTITUTES, DEPT. EG. 30, LONDON, W.4. (ASSOCIATED WITH H.M.V.). G 619

EXPERIMENTAL WORK.

RESEARCH ENGINEERS LIMITED,

Northampton Grove, Canonbury, London, N.1. Canonbury 4244/5/6. We have over 25 years' experience of experimental work and prototypes. We design, develop and manufacture special purpose and labour saving machines, all at the above address. Our range is from the smallest scientific instruments to 3- or 4-ton machines. After a prototype machine has been made and found satisfactory we can manufacture as many as are required in our Works. G 656

TENDERS.

GOVERNMENT OF IRAQ.

DEVELOPMENT BOARD AND MINISTRY OF DEVELOPMENT.

NASIRIYAH ROAD BRIDGE CONTRACT B/8 (1956)

THE DEVELOPMENT BOARD AND MINISTRY OF DEVELOPMENT invites **TENDERS** from experienced Civil Engineering Contractors for the construction of a **STEEL CANTILEVER ROAD BRIDGE** approximately 180 metres long and 11 metres wide over the River Euphrates at Nasiriyah, together with the **STEEL AND REINFORCED CONCRETE APPROACH VIADUCTS** and embankments thereto.

The Contract Documents and Conditions as to Tendering may be inspected on and after the 17th day of January, 1956, at any of the following places:—

(*a*) The offices of the DIRECTORATE GENERAL OF LEGAL AFFAIRS AND CONTRACTS, MINISTRY OF DEVELOPMENT, BAGHDAD, IRAQ.
(*b*) THE EMBASSIES AND LEGATIONS OF IRAQ IN WASHINGTON, PARIS, ROME, BRUSSELS, BONN, CAIRO, KARACHI AND NEW DELHI.
(*c*) The offices of RENDEL, PALMER & TRITTON, 125, VICTORIA STREET, LONDON, S.W.1, ENGLAND.

Firms desiring to Tender may obtain two copies of the Contract Documents between the 17th day of January, 1956, and the 17th day of March, 1956 (both days inclusive) from the DIRECTORATE GENERAL OF LEGAL AFFAIRS AND CONTRACTS, MINISTRY OF DEVELOPMENT IN BAGHDAD, or the offices of RENDEL, PALMER & TRITTON IN LONDON, upon payment of twenty-five Iraqi Dinars or the equivalent thereof for each two sets of documents.

Tenders must be accompanied by a deposit of I.D. 10,000/- (Ten thousand Iraqi Dinars) either in cash or by a letter of guarantee to be made by or through an approved Bank established in Iraq. Fully detailed conditions as to this deposit may be ascertained from the "Conditions of Tender" attached to the Contract Documents.

Tenders must be submitted to the DEVELOPMENT BOARD (DIRECTORATE GENERAL OF LEGAL AFFAIRS AND CONTRACTS, MINISTRY OF DEVELOPMENT), BAGHDAD, IRAQ, in sealed envelopes endorsed clearly on the outside with the words "NASIRIYAH ROAD BRIDGE," and will be received up to noon on the 17th day of April, 1956.

A Memorandum of Capacity, Method of Procedure and Articles of Association must be submitted at the same time.

Particular attention is drawn to Clause 8 of the "Conditions of Tender" stating that tenders will be accepted only from firms of Contractors who have previously executed works of a similar character and magnitude.

Tenders not submitted within the time specified or not accompanied by a receipt of the deposit, or a letter of guarantee or if the Tenderer resides in a Liwa in Iraq where a Chamber of Commerce exists, by a Certificate of Membership of a Chamber of Commerce, shall be neglected.

The Board does not bind itself to accept the lowest or any Tender.

MINISTER OF DEVELOPMENT. J 737

METROPOLITAN WATER BOARD.

TENDERS FOR THE SUPPLY OF STORES, ETC.

TENDERS are invited for the supply of the following stores and services for the period of 12 months commencing 1st April, 1956.

Contract No.
1. **FIREBRICKS, FLETTON, STOCK AND ENGINEERING BRICKS, CONCRETE SLABS, EARTHENWARE BASES AND COVERS, CEMENT AND TARMACADAM.**
2. **BRUSHES, BROOMS AND HANDLES.**
3. **CAST AND SPUN IRON STRAIGHT PIPES, CAST IRON SPECIALS.**
4. **UNIFORM AND MECHANICS' CLOTHING, CAPS, BOOTS, ETC.**
5. **COTTON WASTE, CLEANING CLOTH, HEMP, TARPAULINS, ETC.**
8. **MILD STEEL BARS, PLATES, SHEETS, ETC.**
9. **BOLTS AND NUTS, SCREWS, FILES, STEEL TUBES, SHOVELS, ETC.**
10. **LEAD PIPE AND SOLDER.**
11. **FUEL OIL, KEROSENE AND MOTOR SPIRIT.**
13. **SOAP, METAL POLISH, OILMAN'S SUNDRIES, ETC.**
14. **RUBBER INSERTION AND SHEET ETC., SUCTION, DELIVERY AND CHEMICAL HOSE, CANVAS FIRE HOSE AND RUBBER LINED HOSE.**
19. **SMALL IRON CASTINGS, VALVE, BOXES, HYDRANT BOXES, STOPCOCK BOXES AND NON-FERROUS CASTINGS.**
20. **STOPCOCKS, FERRULE STOPCOCKS, UNIONS, DISC FITTINGS AND GUNMETAL OUTLETS FOR HYDRANTS.**
21. **SLUICE VALVES AND SPINDLES, FIRE HYDRANTS, FLANGED SOCKETS, FLANGED SPIGOTS AND HYDRANT INDICATOR PLATES.**
23. **THE PERIODICAL INSPECTION, REPAIR AND MAINTENANCE OF WEIGHING APPARATUS.**
24. **ELECTRIC LAMPS AND FLUORESCENT TUBES.**
26. **THE REMOVAL OF FURNACE REFUSE.**
27. **PHOTO PRINTS, ETC.**

Tenders must be submitted on the official forms which may be obtained from the Chief Engineer by personal application at the offices of the Board (Room 171) or upon forwarding a stamped addressed envelope (not smaller than 15 in. by 10 in.).

Applicants should refer to the number of the contract for which tender forms are required.

Tenders, enclosed in sealed envelopes, addressed to the UNDERSIGNED, and endorsed in the manner indicated in the form of tender, must be delivered at the offices of the Board (Room 122) not later than 12 noon, Thursday, 9th February, 1956.

The Board do not bind themselves to accept the lowest or any tender.

S. D. ASKEW,
CLERK OF THE BOARD.
OFFICES OF THE BOARD, NEW RIVER HEAD, ROSEBERY AVENUE, LONDON, E.C.1. J 980

PUBLIC NOTICE.

UNIVERSITY OF GLASGOW.

FACULTY OF ENGINEERING.

POST-GRADUATE COURSES IN MECHANICAL ENGINEERING.

The University offers the following special courses for designers and others employed in Mechanical Engineering and Chemical Engineering.

SHORT FULL-TIME COURSES.

COURSE IN HEAT TRANSFER.

April 23rd to May 4th, 1956.
Commencing 9.30 a.m., April 23rd.

Fluid to fluid heat exchangers; theory of convective heat transfer coefficients; dimensional similarity; steady and transient states; numerical methods; radiation: geometrical factors; radiation from gases and flames; applications to the design of boilers, furnaces and heat transfer equipment in general.

Fee: Ten guineas.

COURSE IN PLASTICITY IN MECHANICAL ENGINEERING DESIGN.

May 7th to 18th, 1956.
Commencing 9.30 a.m., May 7th.

Fundamental experimental work on tubes; general elementary mathematical theory; applications to shrink fits, pressure vessels, compression members and general mechanical design. Related topics; creep in metals, internal damping, photo-elasticity.

The forenoons will be devoted to lectures and the afternoons to experimental work.

Fee: Ten guineas.

These courses are open to all who may wish to attend.

Applications for admission to any of the above courses should be addressed to the REGISTRAR, THE UNIVERSITY, GLASGOW, W.2, as soon as possible. K 95

LONDON COUNTY COUNCIL.

ROBERT BLAIR FELLOWSHIP IN APPLIED SCIENCE AND TECHNOLOGY.

Applications are invited for the award of the Robert Blair Fellowship tenable for one year of advanced study or research abroad in applied science and technology. The value of the award is subject to variation, and, if the country selected should be Canada or the U.S.A. may be £2,000, subject to income tax.

Candidates must be British subjects and at least 21 years of age. Further particulars and application forms may be obtained from the EDUCATION OFFICER (EO.WA/14), THE COUNTY HALL, S.E.1, (s.a.e. f'scap), for return by 1st March, 1956. (92). K 72

PUBLIC APPOINTMENTS.

UNIVERSITY OF LONDON KING'S COLLEGE will require on 1st April, 1956, or as soon thereafter as possible,

A LECTURER IN CIVIL ENGINEERING and a **LECTURER IN MECHANICAL ENGINEERING.** Applicants should be honours graduates with some practical experience and an interest in research. Salary on the scale £700 by £50 to £1400 with starting point according to qualifications and experience, together with Family Allowances and F.S.S.U. benefits.—Particulars and Application forms from the REGISTRAR, KING'S COLLEGE, STRAND, W.C.2, whom completed applications must reach by 29th February. J 991

AIR MINISTRY Works Designs Branch requires (A) in LONDON

(1) DESIGNER/DRAUGHTSMEN (ORDER NO. 2308) FOR BULK PETROLEUM STORAGE AND PUMPING INSTALLATIONS experienced in one or more of the following:—(*a*) storage tank layout and design, (*b*) pump house and plant layout, (*c*) development of pipe line schemes (*d*) hydraulic calculations. Technical training to O.N.C. standard required. Salaries up to £725 p.a.

(2) STRUCTURAL ENGINEERING DESIGNER/DRAUGHTSMEN (ORDER NO. 2304) for reinforced concrete or structural steel with sound technical training and several years varied experience in design/detailing of:—(*a*) Reinforced concrete construction for all types of buildings, or (*b*) steel framed sheds, warehouses and similar buildings, and

CIVIL ENGINEERING DESIGNER/DRAUGHTSMEN (ORDER NO. 2305) experienced in one or more of the following branches of engineering:—(*a*) Earthworks and Stormwater Drainage, (*b*) Foul Drainage and small disposal works, (*c*) Water Pumping Treatment and Distribution. Salaries up to £850 p.a.

(B) IN LONDON AND PROVINCES (with liability for overseas service)

ELECTRICAL ENGINEERING DRAUGHTSMEN (ORDER NO. 2307) experience in preparation of schemes for illumination and electrical equipment of buildings or in electrical distribution H.V. and M.V. Technical training to O.N.C. standard or equiv. an advantage. Salaries up to £850 p.a. Starting pay dependent upon age, quals., and experience. Paid overtime. Long term possibilities with pensionable and promotion prospects. Natural born British subjects. Write stating age, quals., employment details including type of work done to any Employment Exchange quoting Borough and relevant Order No. G 624

LONDON COUNTY COUNCIL.

HACKNEY TECHNICAL COLLEGE, April 1956 or as soon as possible thereafter.

LECTURER IN MECHANICAL ENGINEERING subjects to teach up to H.N.C. standard in Machine tools and Metrology together with Machine Shop Engineering subject to final City and Guilds. Should be graduate or corporate member of appropriate professional institution; first-class workshop experience is essential. Teaching experience desirable. Burnham F.E. Salary Scale: £965 by £25 to £1065. Individual minimum and maximum salaries according to age, qualifications and experience, plus London allowance.—Application forms from SECRETARY at COLLEGE, DALSTON LANE, E.8, returnable by 11th February (100). K 146

ADMIRALTY.
ROYAL NAVAL SCIENTIFIC SERVICE.

DRAUGHTSMEN required in Admiralty Research and Development Establishments in London (Teddington area), Portsmouth, Weymouth, and Baldock (Herts) for the design of experimental apparatus needed for fundamental research or for fitting in H.M. ships. Experience is necessary in any of the following classes of equipment: light to medium electrical, electro-mechanical, precision mechanical and electronic.

Candidates must be British aged 21 years or over, with at least 3 years' practical workshop training and, preferably, with drawing office experience and/or possession of the O.N.C. or equivalent.

Appointments unestablished, but opportunities will occur to compete for established posts and for promotion.

Starting pay (London rate), £463 10s. per annum (aged 21), £635 (aged 28) rising by 4 increments to £725 per annum; slightly less in the Provinces.

Apply stating age, training, experience and qualifications to ADMIRALTY, SANCTUARY BUILDINGS (ROOM 151), GREAT SMITH STREET, LONDON, S.W.1. G 636

ASSISTANT EXPERIMENTAL OFFICERS required at NATIONAL PHYSICAL LABORATORY, TEDDINGTON, for work in Physics, Mathematics, Mechanical and Electrical Engineering, Metallurgy and Naval Architecture. Candidates must have G.C.E. (Advanced) in at least two scientific subjects, or equivalent. Over 22 pass degree, H.N.C. or equivalent normally expected. Inclusive annual remuneration 45½ hour week: (men), £230 (at 18)-£721. Women slightly less. Equal Pay Scheme.—Application forms from M.L.N.S., TECHNICAL AND SCIENTIFC REGISTER (K), 26, KING STREET, LONDON, S.W.1, quoting A485/5A. Closing date 11th February, 1956. K 126

MECHANICAL ENGINEER required by MINISTRY OF SUPPLY, ROCKET PROPULSION DEPARTMENT of Royal Aircraft Establishment, Westcott, Bucks, to work on problems of high speed machinery, fluid control systems, combustion, etc., or on general performance duties. 1st or 2nd class honours degree or equivalent qualification in Mechanical Engineering. Experience appropriate to above duties desirable. Appointment according to age, experience, etc., as Senior Scientific Officer (minimum age 26 with at least 3 years' post-graduate research experience) or Scientific Officer (minimum age 21). Salary within ranges: S.S.O. £1030-£1185, S.O. £488 10s.-£885 (Superannuable).—Application forms from M.L.N.S., TECHNICAL AND SCIENTIFIC REGISTER (K), 26, KING STREET, LONDON, S.W.1, quoting C21/6A/BG. Closing date 18th February, 1956. K 154

ADMIRALTY.
ROYAL NAVAL SCIENTIFIC SERVICE.

ENGINEERS AND PHYSICISTS (PARTICULARLY WITH ELECTRONICS) required in Experimental Officer and Assistant Experimental Officer grades in Experimental Establishments in London, Portsmouth, Weymouth areas, Gloucestershire and Scotland. Qualifications: British subjects, minimum of H.S.C. (Pass degree, H.N.C. or near equivalent an advantage). London salary (men), E.O. £790-£960, A.E.O. £320 10s.-£700 (according to age). Appointments unestablished but opportunities to compete for established posts.—Application forms from M.L.N.S., TECHNICAL AND SCIENTIFIC REGISTER (K), 26, KING STREET, LONDON, S.W.1, quoting A214/5A. J 758

THE NATIONAL COAL BOARD, OPENCAST EXECUTIVE has vacancies for

SENIOR STAFF to take responsible posts in connection with opencast coal production. Administrative ability coupled with sound practical experience in the conduct of large civil engineering works in the field is essential. A recognised technical qualification in Civil Engineering is also desirable.

Commencing salaries will be according to qualification and experience within a salary range £1100 to £1400 per annum, but opportunities exist for promotion of the right men to more senior appointments.

The Board's Superannuation Scheme will cover these posts.

Applications giving full details of age, qualifications and experience should be made to the ESTABLISHMENTS OFFICER, NATIONAL COAL BOARD, OPENCAST EXECUTIVE, 85/87, JERMYN STREET, LONDON, S.W.1, within 10 days of the appearance of this advertisement. K 89

COLLEGE OF TECHNOLOGY, BIRMINGHAM

DEPARTMENT OF MECHANICAL AND PRODUCTION ENGINEERING.

Applications are invited for the following post:—

ASSISTANT GRADE "B" in the Production Engineering Section of the Department for work concerned with National Certificate and City and Guilds Courses.

Candidates should preferably have a Degree in Engineering and/or Corporate Membership of the Institution of Production Engineers or Mechanical Engineers. Teaching experience is desirable and industrial experience regarding manufacturing plant, processes and production methods is essential.

Salary will be in accordance with the Burnham (Further Education) Scale for Grade "B" Assistants (Men), £525 by £25 (final increment £20) to £825 with additional graduate and training allowances where applicable. In fixing the commencing salary, account will be taken of teaching and industrial experience.

Further particulars and form of application may be obtained from the REGISTRAR, COLLEGE OF TECHNOLOGY, SUFFOLK STREET, BIRMINGHAM, 1, on receipt of a stamped addressed foolscap envelope. Completed forms should be returned not later than two weeks after the appearance of this advertisement.

K. R. PILLING,
CLERK TO THE GOVERNING BODY. K 80

PORTSMOUTH COLLEGE OF TECHNOLOGY.

LECTURER is required in the Electrical Engineering Department to take Electrical Power and General Electrical Technology. Candidates must have a Graduate (or equivalent) qualification and some industrial experience.

Salary will be on the Burnham Technical scale for either Lecturer or Assistant, Grade B.

Forms of Application may be obtained from the REGISTRAR, and should be returned duly completed as soon as possible.

E. G. BARNARD,
CHIEF EDUCATION OFFICER. K 128

TRAINING OFFICERS:

Vacancies exist with the UNITED KINGDOM ATOMIC ENERGY AUTHORITY at SPRINGFIELDS WORKS, NR. PRESTON, and WINDSCALE WORKS, CUMBERLAND.

DUTIES: The Officers will be responsible to the Training Manager of the Works concerned and will be required to devise and implement training schemes covering non-industrial staff and industrial employees.

QUALIFICATIONS AND EXPERIENCE.

SPRINGFIELDS (reference 1251) must have an honours degree in Chemistry or A.R.I.C. or equivalent qualifications, together with 3 years' experience in a Works or Industrial Laboratory.

WINDSCALE (reference 1250) candidates must have served a recognised apprenticeship or have equivalent training and be Corporate Members of the Institution of Mechanical or Electrical Engineers or have equivalent qualifications.

Experience of training in technical colleges or in industry will be an advantage for both posts.

SALARY: £728 rising by annual increments of approximately £30 to £1130 p.a.

Successful candidates under the age of 55 will be required to join the Authority's Contributory Pension Scheme, which includes Widows' and Dependants' benefits.

There are housing schemes in operation for married officers.

Suitably qualified persons are invited to send a postcard quoting the appropriate reference to the RECRUITMENT OFFICER, U.K.A.E.A., I.G.H.Q., RISLEY, NR. WARRINGTON. Closing date: 17th February, 1956. K 97

ENGINEERS.

Vacancies exist with the UNITED KINGDOM ATOMIC ENERGY AUTHORITY for the above posts in the Inspection and Progress Branch of the Industrial Group at Risley, Near Warrington.

DUTIES: Control of Inspection and Progress at manufacturers works of a wide variety of plant, equipment, material and stores involving close liaison with design and construction engineers. Considerable travelling in the United Kingdom will be involved.

QUALIFICATIONS AND EXPERIENCE: Applicants must have served a recognised engineering apprenticeship or pupilage and have Corporate Membership of a Senior Engineering Institution or equivalent qualifications. They must have experience in planning, designing, production or inspection of medium or heavy plant and be capable of inspecting and programming work through the contractors shops and of assisting contractors with production capacity and material difficulties.

Salary: £1130 rising by annual increments of approximately £35 to £1435 p.a.

Successful candidates, if under the age of 55 will be required to join the Authority's Contributory Pension Scheme, which includes Widows' and Dependants' benefits.

Suitably qualified persons are invited to send a postcard quoting reference 1.264 for form of application to RECRUITMENT OFFICER, U.K.A.E.A., I.G.H.Q., RISLEY, NR. WARRINGTON. Closing date 17th FEBRUARY, 1956. K 127

CENTRAL ELECTRICITY AUTHORITY.

MIDLANDS DIVISION.

SENIOR DRAUGHTSMAN (MECHANICAL) is required in the Generation Construction Department at Divisional Headquarters, Moseley, Birmingham. N.J.B. service conditions, superannuable appointment, salary with Schedule "D," Grade 5, £640 to £740 per annum.

Applicants should have had sound technical training and practical experience preferably associated with power station, chemical or other heavy industrial plant. Good conditions of employment and hol days.

Apply, quoting Vacancy No. 196MD on form AE6, available from the ESTABLISHMENTS OFFICER, 53, WAKE GREEN ROAD, MOSELEY, BIRMINGHAM, by 4th February, 1956. K 128

NORTH WEST METROPOLITAN REGIONAL HOSPITAL BOARD.

PRINCIPAL ASSISTANT ENGINEER (SCALE II) required. Mechanical and Heating and Ventilating. The post is a new one and arises from new building and engineering projects on which the Board are engaged, including a new hospital at Welwyn. Duties will include design on mechanical side, preparation of briefs for consulting engineers and supervision of both mechanical and heating and ventilating sections. Applicants must be Corporate Members of the Institution of Mechanical Engineers.

Salary scale:—£1050 by £50 (5) by £25 to £1275 plus £50 London Weighting.

Apply, giving age, qualifications (with dates) and experience with names of two referees, to SECRETARY, NORTH WEST METROPOLITAN REGIONAL HOSPITAL BOARD, 11A, PORTLAND PLACE, W.1, by 16th February. K 133

COUNTY BOROUGH OF CROYDON EDUCATION COMMITTEE.

CROYDON TECHNICAL COLLEGE, FAIRFIELD, CROYDON.
Principal: H. FALKNER, M.Sc.

Applications are invited for

1. The **POST OF SENIOR LECTURER IN THE MECHANICAL ENGINEERING DEPARTMENT** (£1065-£1275 per annum).

The work of the Department includes Higher National Certificate Courses in both Mechanical and Production Engineering, and City and Guilds Final courses in trade subjects.

2. The **POST OF ASSISTANT, GRADE B, IN THE MECHANICAL ENGINEERING DEPARTMENT.**

Teaching will include Marine Shop Practice, Processes, and Science to City and Guilds Machine Shop Engineering. Ability to assist in work leading to City and Guilds Certificate for Motor Vehicle Mechanics will be an advantage. Duties to commence as soon as possible.

Salary in accordance with the Burnham Technical Scale with London Area Allowance (£48 or £36 per annum).

Further particulars and forms of application may be obtained from the undersigned, on receipt of a stamped addressed envelope, and completed forms should be returned to the Principal within fourteen days of the appearance of this advertisement.

R. WEARING KING,
CHIEF EDUCATION OFFICER.
EDUCATION OFFICE,
KATHERINE STREET,
CROYDON, SURREY. K 141

THE BRITISH SOCIETY FOR RESEARCH IN AGRICULTURAL ENGINEERING invites applications for appointment as an

EXPERIMENTAL OFFICER at the National Institute of Agricultural Engineering. The post is one dealing with a variety of mechanical engineering problems and the successful candidate will be expected to assist in theoretical and practical studies. Candidates should have a degree in Engineering or equivalent. Salary scale £745 to £920. Minimum age, 28.

Application forms from SECRETARY, N.I.A.E., WREST PARK, SILSOE, BEDS., on receipt of stamped addressed foolscap envelope. Completed forms to be submitted within 14 days of the appearance of this advertisement. K 140

CENTRAL ELECTRICITY AUTHORITY,
SOUTH EASTERN DIVISION.

Positions are available for ambitious engineers in the Electricity Supply Industry which offer good opportunities of promotion on the generation side—mechanical, electrical, civil and chemical engineering. If you are interested send to the PERSONNEL OFFICER, CENTRAL ELECTRICITY HOUSE, LOWER HAM ROAD, KINGSTON-ON-THAMES, for a brochure giving details of terms, conditions and careers for junior and senior positions. Please quote (EG). Vacancies at present offer salaries ranging from £500-£1215 max. per annum dependent upon position. K 110

STAFFORDSHIRE EDUCATION COMMITTEE.
COUNTY TECHNICAL COLLEGE, STAFFORD.

Principal: A. TORKINGTON, B.Sc.(Hons.), M.I.Mech.E.

Applications are invited for the following appointments to commence on or before the 1st May, 1956:—

(1) **LECTURER TO TEACH MATHEMATICS** up to final B.Sc.(Eng.) Candidates should have a degree in Mathematics and teaching experience in a Technical College.

(2) **GRADE A ASSISTANT** with suitable qualifications to teach Fitting and Machine Shop Engineering Practice to City and Guilds standard.

Salaries for the above posts are according to the Burnham Scales for Technical Teachers, viz.: Lecturer, £965 by £25 to £1065; Grade A Assistant, £450 by £18 to £725, plus allowances for qualifications. For the Grade A post, starting salary will depend on training and years of experience in teaching and/or industry.

Forms of application and further particulars may be obtained from the undersigned on receipt of a stamped addressed foolscap envelope. Applicants are requested to state for which post forms are required. Completed forms must be returned not later than 6th February, 1956.

J. H. P. OXSPRING,
Director of Education.

Dept. F.E.,
County Education Office,
Stafford. K 111

APPOINTMENTS OPEN.

THE ENGAGEMENT OF PERSONS answering these advertisements must be made through a Local Office of the Ministry of Labour or a Scheduled Employment Agency if the applicant is a man aged 18-64 inclusive or a woman aged 18-59 inclusive unless he or she, or the employment, is excepted from the provisions of the Notification of Vacancies Order 1952.

It is advisable when sending testimonials to forward copies and NOT originals.

NORTH BRITISH LOCOMOTIVE CO., LTD., DIESEL ENGINE DIVISION, requires

A DRAUGHTSMAN capable of preparing layouts for engines and supervision of detailing. Pension scheme, five-day week.—Apply in writing to (IGD) PERSONNEL MANAGER, SPRINGBURN, GLASGOW, N.1. K 16

JUNIOR DRAUGHTSMEN, having completed National Service, required for work on large chemical plant installations. A.E.S.D. minimum rates or above. Five-day week and superannuation scheme.—Apply by letter giving details of technical education to the CHIEF DRAUGHTSMAN, LAPORTE CHEMICALS LIMITED, CLIFTON HOUSE, EUSTON ROAD, LONDON, N.W.1. G 575

BRITISH PETROLEUM COMPANY LIMITED offers

STUDENT APPRENTICESHIPS IN MECHANICAL AND CHEMICAL ENGINEERING for men who have completed their period of National Service and who possess G.C.E. in five subjects of which Mathematics and/or Physics must have been passed at "A" level and English at "O" level. Age 19-22. The apprentices will attend a Technical College for a full-time Sandwich Course of Studies during their first six months and will then go to a Refinery for practical training. The Course is of 4 years duration.—Applications giving full details of education and experience should be addressed to MANAGER, RECRUITMENT BRANCH, quoting reference H.3570, to BOX 8347, c/o 191, GRESHAM HOUSE, E.C.2. G 608

MECHANICAL AND ELECTRICAL SERVICES ENGINEER required by Consulting Engineers in Birmingham. Permanent post with pension scheme.—Reply in confidence giving qualifications, previous experience, age, etc., to BOX No. 300, GLOVERS ADVERTISING LTD., 351, OXFORD STREET, LONDON, W.1. G 596

SENIOR MECHANICAL ENGINEERING DRAUGHTSMEN required for interesting work on large chemical plant installations. Experience in this type of work is desirable but not essential, applicants with general mechanical engineering experience will be favourably considered. The posts offer excellent opportunities with generous salaries commensurate with experience and ability. Offices situated in the N.W.1 London area. Five-day week and superannuation scheme.—Applications, which will be treated in confidence, should give previous experience and qualifications and be addressed to the CHIEF DRAUGHTSMAN, LAPORTE CHEMICALS LIMITED, CLIFTON HOUSE, EUSTON ROAD, LONDON, N.W.1. G 576

BRITISH PETROLEUM COMPANY LIMITED requires an

INSPECTING ENGINEER—AGED 30-35—familiar with office routines. Degree in Engineering essential and preference will be given to the applicant who is also a member of an Engineering Institution. Should have good knowledge of operation and maintenance of machinery and a sound practical workshop experience. May be required to act as deputy to the Chief Inspecting Engineer during his absence. Salary according to age, qualifications and experience. Non-contributory Pension Scheme. Luncheon Club.—Write giving full details, quoting H.3484, to BOX 8172, c/o 191, GRESHAM HOUSE, E.C.2. G 594

THE AVON INDIA RUBBER CO., LTD., MELKSHAM, WILTS., require an

ELECTRICAL DRAUGHTSMAN. He should be experienced with power and lighting distribution and motor control-gear work, and should possess at least O.N.C. qualification. Salary and working conditions will be made attractive to the right man. —Apply CHIEF ENGINEER, giving age and full particulars. J 913

An expanding and well-known London Light Engineering Company wishes to appoint a

SENIOR EXECUTIVE to take full charge of Engineering and the Administration of two Factories, one of which is in the provinces. This is a new appointment and should lead to a seat on the Board. Candidates should be between 40 and 45, have an Honours Degree in Mechanical Engineering, and have already held a position as Works Manager. Sound knowledge of the administration of a Design Office, Budgetary Control, Production Planning, Work Study and Estimating are essential and in addition familiarity with techniques of Machining, Welding and Assembly. This position will carry a salary of not less than £2000 per annum and will be pensionable. Candidates should give details of scholastic career at school and subsequently, positions held, salaries earned in each, and brief particulars of experience gained.—Reply in full confidence to BOX J 908, Offices of ENGINEERING.

THE AERODYNAMICS DEPARTMENT OF ARMSTRONG SIDDELEY MOTORS has vacancies for both

SENIOR AND JUNIOR DEVELOPMENT ENGINEERS for work on axial flow compressors, turbines and general airflow. A Degree in Mechanical Engineering and previous experience in this type of work an advantage but not essential. Initial salaries range from £650 to £1050 per annum, dependent on age, experience and qualifications but superscale rates would apply to senior experienced men. Excellent prospects and good pension fund. Applicants should give full details quoting Reference Airflow 2, to TECHNICAL PERSONNEL MANAGER, ARMSTRONG SIDDELEY MOTORS, COVENTRY. G 625

ASSISTANT CIVIL ENGINEERS required for large Iron and Steel Works in the Midlands. Conversant in Building Construction, Reinforced Concrete Structures, Excavations and Foundations, Site Levelling and Setting-out, Preparing Scheme and Detail Drawings. Work is varied and covers a large field for experience. Applicants should hold a degree or be studying for same. Please state Age, Positions held and salary expected.—Apply in writing, to GENERAL MANAGER, IRON AND STEEL WORKS, CORBY, NORTHANTS. J 992

MECHANICAL ENGINEER required by International Group for work as Development Engineer in MIDDLE EAST Oilfields. Duties would include design work in connection with pumping, storage and loading of oil, transmission of natural gas, water storage, steam and diesel engine installations, industrial buildings, etc. Applicants should possess A.M.I.Mech.E. or equivalent, and have had several years' experience on work described. Professional qualification not essential if engineering background otherwise satisfactory. Two year tour in first instance and substantial salary, payable also while on leave. Married accommodation and free family passages available. Write asking for application form and sending brief details of career to BOX E.G. 568, c/o 191, GRESHAM HOUSE, E.C.2. J 998

CANADA

LAMINATED STRUCTURES LIMITED

Canada's leading designers and fabricators of glued laminated and sawn timber structures, have

THREE PERMANENT OPENINGS

For

DESIGN ENGINEERS

AT THEIR HEAD OFFICE IN MONTREAL

Applicants must hold a recognised degree and possess at least two years' general structural design experience. Knowledge of timber construction would be an advantage but is not essential.

Starting salary ranges from $3,600 to $4,800 (£1,300—£1,750) per annum depending on experience. Group insurance and pension plan available. Boat fare to Montreal paid under contract basis. Apply in writing immediately, giving personal details and full particulars of past experience to:—

T. A. ELDRIDGE, c/o W. H. WILLATTS & ASSOCIATES, 28 ST. GEORGE STREET, HANOVER SQUARE, LONDON, W.1

Personal interviews will be conducted in London, 13th—18th February, 1956.

K 119

Classified Advertisements continued on Page 4

TECHNICAL LIAISON

THE GUEST KEEN & NETTLEFOLDS GROUP RESEARCH LABORATORY

has an opening for

QUALIFIED MEN to be engaged on technical liaison work between the laboratory and production units in the group. An important part of the duties will be those of technical secretaries, and in addition to a degree or equivalent qualification, preferably in Engineering or Metallurgy, applicants should have some experience of work in industry and be competent to convey information by both the written and the spoken word. Applicants should be between 25 and 35 years of age and should write, giving full details of experience, to the Director of Research, G.K.N. Group Research Laboratory, Birmingham New Road, Lanesfield, Wolverhampton. All communications to carry reference number L.I.1. J 975

JIG & TOOL DRAUGHTSMEN
DESIGN DRAUGHTSMEN

JOSEPH LUCAS LIMITED, BURNLEY,

Manufacturers of Aircraft and Motor Equipment.

Require capable ambitious men to assist in the work of **GAS TURBINE DEVELOPMENT.** Here is an opportunity for men with initiative to obtain a progressive position. The work is extremely interesting and demands a high degree of skill and ingenuity. A generous pension scheme provides an assured future, the working conditions are excellent and full restaurant services are provided. High salaries are paid to the right men.

Apply to :

The Personnel Manager, Hargher Clough Works, Burnley. J 868

ARMSTRONG SIDDELEY MOTORS has vacancies in their

GAS TURBINE DEVELOPMENT STAFF FOR WORK ON SAPPHIRE AND VIPER ENGINES. Applicants must have a University Degree. Previous experience although desirable, is not essential. Initial salaries in the range of £600-£1000 per annum, dependant on age, experience and qualifications. Due to heavy forthcoming commitments and consequent expansion of departments, prospects for men of the right calibre are unusually good.—Applications with full details to Reference EXP/SV, TECHNICAL PERSONNEL MANAGER, ARMSTRONG SIDDELEY MOTORS, COVENTRY. G 623

ARMSTRONG SIDDELEY MOTORS have vacancies for both

SENIOR AND JUNIOR ENGINEERS

for investigation of vibration problems on gas turbine development engines. Degree or H.N.C. in Mechanical Engineering or Electrical Engineering essential. Electrical Engineers should have some mechanical engineering experience. Applicants must be capable of using necessary recording equipment. Salaries commensurate with qualifications and experience, together with good pension scheme. —Applications to REFERENCE CO/VP, TECHNICAL PERSONNEL MANAGER, ARMSTRONG SIDDELEY MOTORS, COVENTRY. G 621

QUANTITY SURVEYOR required by Consulting Engineers in Birmingham. Staff pension scheme. Please reply in confidence giving qualifications, previous experience, age, etc., to BOX No. 295, GLOVERS ADVERTISING LIMITED, 351, OXFORD STREET, LONDON, W.1. G 595

WORKS ENGINEER.

Required for medium sized light engineering factory, engaged in a considerable re-organisation programme for its two factories.

Applicants would be required to control all functions of factory maintenance and to co-ordinate existing departments.

Experience is required of repair and alteration of factory buildings, services, heating and ventilating, and power supply. A detail knowledge of preventative maintenance schemes for services and machine tools essential.

Preference will be given to a Chartered Engineer, below the age of 50. This is a senior staff position, with generous salary. A non-contributory superannuation scheme is in operation.

Applicants should submit full details of career and salaries to CLAYTON DEWANDRE CO., LTD., TITANIC WORKS, LINCOLN, for the attention of the General Manager. J 914

DRAUGHTSMEN (SENIOR AND JUNIOR) required for work in connection with the following branches of Coke Oven and Gasworks plants.

(*a*) Mechanical and By-Product Plant.
(*b*) Pipework.
(*c*) Steelwork for Buildings and Conveyors.

Applicants should be competent men able to work with the minimum of supervision. Technical qualifications to O.N.C. or beyond. Good remuneration and prospects for capable men. Pension scheme. Five-day week ; Canteen Facilities.—State age and experience to the PERSONNEL OFFICER (D.O.), WOODALL-DUCKHAM CONSTRUCTION COMPANY LTD., WOODALL-DUCKHAM HOUSE, 63-77, BROMPTON ROAD, LONDON, S.W.3. G 550

ASSISTANT ENGINEER, AGED 25/30 required to assist Engineer and Buyer. Qualifications B.Sc. or equivalent with two years' student apprenticeship. Duties will include visiting manufacturers' works and may lead to an interesting and well paid post overseas. Commencing salary in U.K. £800 to £1100, according to age and qualifications.—APPLY THE BRITISH PHOSPHATE COMMISSIONERS, 2, GROSVENOR GARDENS, LONDON, S.W.1. K 39

SENIOR DRAUGHTSMAN required for important and interesting work in the Steam Turbine Drawing Office, BRUSH ELECTRICAL ENGINEERING CO., LTD., LOUGHBOROUGH. Applicants must have previous experience of this class of work. There is considerable scope for an energetic man capable of working with the minimum of guidance. Conditions of service include good salary and generous non-contributory superannuation scheme.—Please reply to the CHIEF PERSONNEL OFFICER. K 122

APPLICATIONS ENGINEER with experience in the Marine field, required to design and develop control schemes for ships auxiliary drives for A.C. and D.C. ship propulsion. Candidates must have a knowledge of generator and motor design for marine applications. This post offers excellent scope for advancement in a vigorous and expanding company. Conditions of service include generous non-contributory superannuation scheme and an attractive salary will be paid.—Please reply to the CHIEF PERSONNEL OFFICER, BRUSH ELECTRICAL ENGINEERING COMPANY, LTD., LOUGHBOROUGH, LEICS. K 123

DRAUGHTSMEN

STEWARTS AND LLOYDS, LIMITED

require Draughtsmen immediately for the design and layout of pipework for major power-plant schemes. Previous experience on pipework not essential but knowledge of power stations or similar installations desirable. The possession of Higher or Ordinary National Certificates an advantage. Vacancies exist in Birmingham and Wednesbury.

Pensionable posts and good salaries available to those who prove themselves qualified.

Reply to SECRETARY, STEWARTS AND LLOYDS, LIMITED, BROAD STREET CHAMBERS, BIRMINGHAM, stating age, experience and salary required. J 890

BILLINGHAM ICI DIVISION

Vacancies for

MECHANICAL ENGINEERS

The Billingham Factory of Imperial Chemical Industries Limited has grown into one of the largest chemical factories in the world. Some 250 Engineering graduates are already engaged in the various engineering activities necessary to maintain the Division's planned programme of extension, and more are needed.

A satisfying and well paid career is offered to

MECHANICAL ENGINEERS who are willing to assume early responsibility in the fields of

ENGINEERING RESEARCH, DESIGN, PROCESS ENGINEERING AND WORK STUDY. Opportunities for rapid advancement are excellent for men of ability.

These appointments are permanent and pensionable and carry attractive salaries. There is also a profit-sharing scheme in operation. Assistance can be given towards house purchase and removal expenses in the case of married men.

Write, giving full details of age, qualifications and experience to the STAFF MANAGER, IMPERIAL CHEMICAL INDUSTRIES LIMITED, BILLINGHAM DIVISION, BILLINGHAM, CO. DURHAM, quoting reference R.5. K 2

PETER BROTHERHOOD, LTD., Peterborough, require

DRAUGHTSMEN (SENIOR AND JUNIOR) preferably with experience in design of compressors, turbines and steam engines. Permanent positions, five-day week, staff pension scheme.—Write, giving full details age, experience and salary required. Z 426

West End London Consulting Engineers require now **SEVERAL SENIOR AND JUNIOR ENGINEER DRAUGHTSMEN** to prepare designs, contract drawings, specifications, etc., for heating, ventilating, boiler plant and allied mechanical services. Interesting work for factories, office blocks, hospitals, colleges, schools, etc. Opportunity for experienced men with initiative. Five-day week. One week's spring holiday in addition to usual summer two weeks. Bonus and optional superannuation scheme.—Write stating age, experience, qualifications and salary required. BOX G 538, Offices of ENGINEERING.

Seventy-five pounds per month and upwards according to experience offered for

EXPERIENCED DESIGNER in R.C. as applied to commercial buildings. Pension scheme and a permanent position with an old-established company in their London Head Office. Five-day week. A vacancy also exists for Designer/Draughtsman working under Senior Designer with salary from £50 p.m.—Reply BOX G 587, Offices of ENGINEERING.

WANTED

DRAUGHTSMEN to design in aluminium for sales development. Must possess Higher National Certificates in Mechanical Engineering. Location Banbury. Good working conditions and pleasant surroundings. Attractive starting salaries offered up to £800 p.a. with prospects of promotion from drawing board. Pension plan in operation. Send brief details of qualifications and experience to NORTHERN ALUMINIUM CO. LTD., BUSH HOUSE, ALDWYCH, LONDON, W.C.2. G 562

THE CHEMICAL AND INSULATING CO., LTD., DARLINGTON, CO. DURHAM.

ENGINEER

required for planning new construction plant maintenance and preventive maintenance for a wide variety of mechanical and electrical plant in the chemical industry.

Applicants should be between 30-40, have good practical engineering experience and preferably be corporate members of a senior engineering institution or have equivalent qualifications.

The position is a progressive one with prospects, salary will be commensurate with responsibilities, and a contributory pension scheme is in operation.

Apply in writing giving details of education, experience and qualifications. K 30

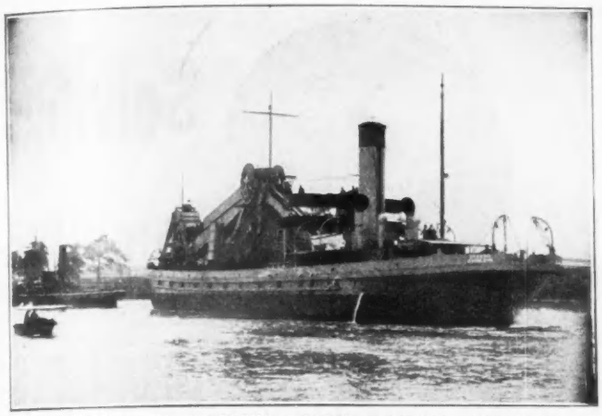
An Industrial Company of repute is about to appoint a

PRODUCTION ENGINEER. This is a new appointment and the successful applicant will be given full scope for initiative and backing in the implementation of his proposals. A top rate man is required, having a University Degree and experience, for preference, in the Engineering industry. A good four figure commencing salary is offered and the prospects are excellent. Applications are invited from men not over 35 years of age. Full particulars of qualifications and posts held with salaries, etc., should be forwarded to BOX K 138, Offices of ENGINEERING.

ENGINEER required by large aluminium company in Birmingham area for interesting sales development work. Honours graduate preferred with structural and strength of materials background, age about 30. Excellent prospects for man with initiative. Salary according to qualifications and experience.—BOX K 42, Offices of ENGINEERING.

Leading manufacturers of container closures in the Midlands have a number of vacancies for ambitious **DESIGN DRAUGHTSMEN** preferably with some experience in this or a similar sphere. Interesting work with excellent salary and every opportunity for promotion to senior position in a rapidly growing organisation. Write in confidence with details of experience, positions held, salary required: to P. A. METAL CLOSURES LIMITED, BROMFORD LANE, WEST BROMWICH. G 627

Classified Advertisements continued on Page 105



OIL-BURNING TWIN-SCREW HOPPER DREDGER "OTAKOU"
constructed for the
OTAGO HARBOUR BOARD, DUNEDIN, NEW ZEALAND.
Dimensions: 258 ft. × 20 ft. Hopper capacity 2,000 tons.
Speed loaded: 9½ knots. Dredging capacity per hour: 1,000 tons.

DREDGING PLANT

TO THE LARGEST DIMENSIONS AND CAPABILITIES

PATENT CUTTER SUCTION DREDGERS, PATENT DIPPER DREDGERS, BUCKET HOPPER DREDGERS, SUCTION HOPPER DREDGERS, HOPPER BARGES, PIPE LINES, FLOATING CRANES, etc.

NEW BUCKETS, LINKS, PINS, GEARING, etc., supplied for existing Dredgers.

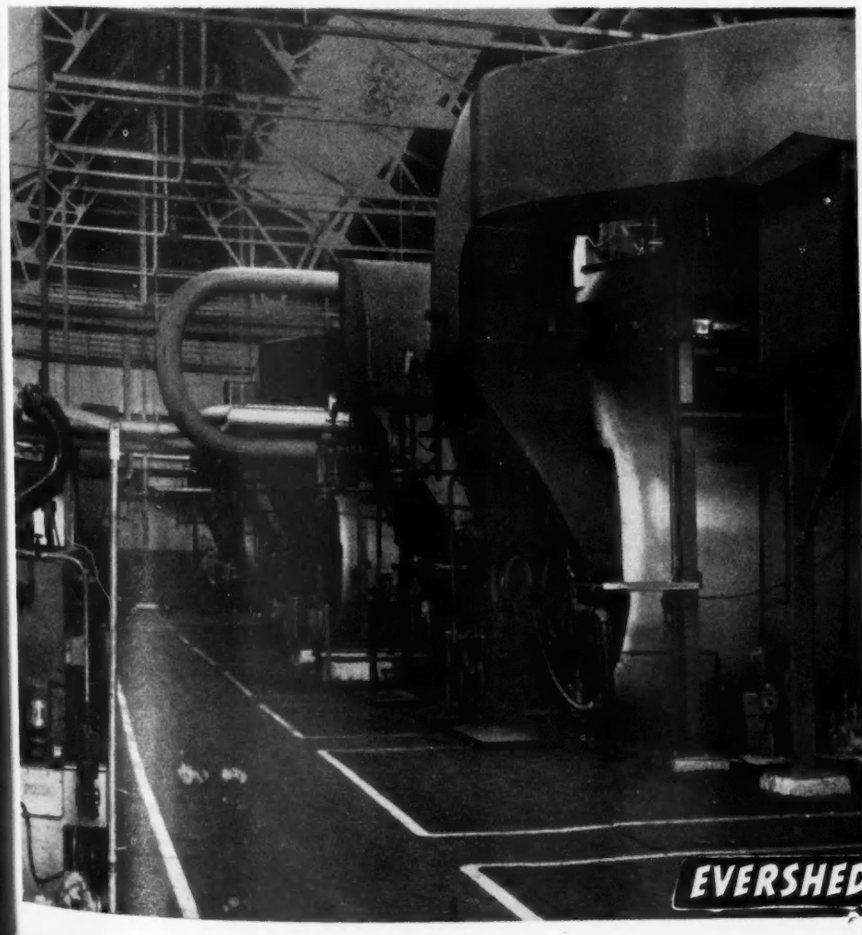
FLEMING & FERGUSON, Ltd.,

SHIPBUILDERS & ENGINEERS, PAISLEY, SCOTLAND,
Phone: Paisley 4121. *Teleg. Address: "Phœnix, Paisley."*
London Agents: Messrs. Nye & Menzies, Ltd., Capel House, 62, New Broad Street, London, E.C.2.
Telephone: LONDON WALL 4846.

STEAM TRAPS & THERMOSTATS
for all purposes
The HORNE ENGINEERING Co. Ltd.
35, PITT ST. GLASGOW.

CONVEYOR SPECIALISTS SINCE 1906

Geo. ROBSON & CO. (CONVEYORS) LTD., Hodgson Street, SHEFFIELD
Phone: SHEFFIELD 27463/4



THE
A.B.C.
OF FUEL ECONOMY

Automatic Boiler Control by EVERSHED

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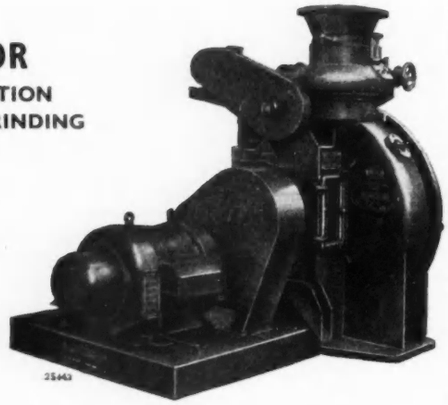

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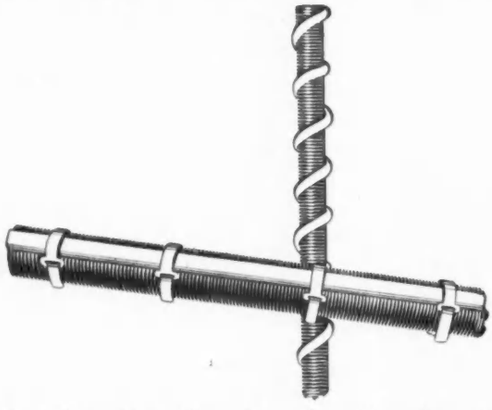

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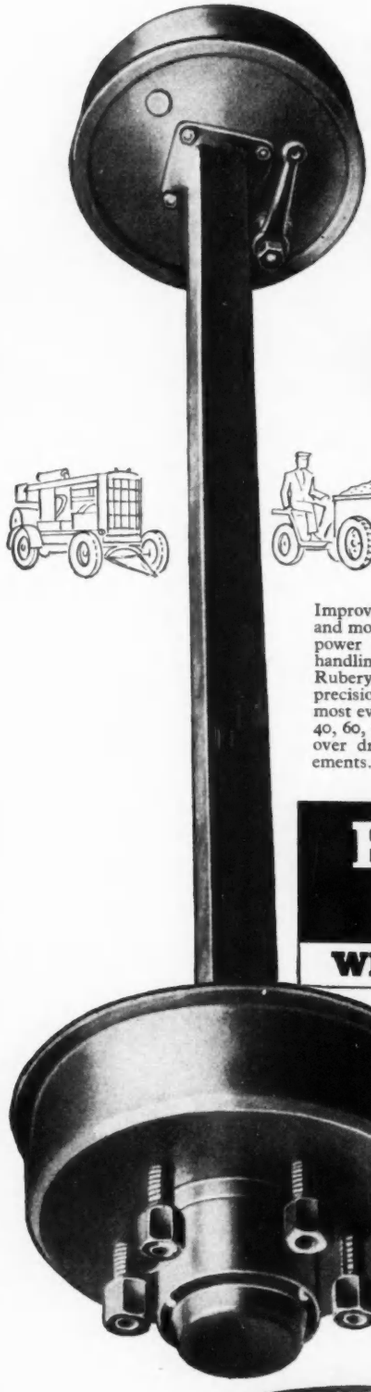

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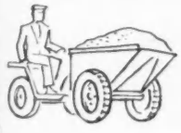

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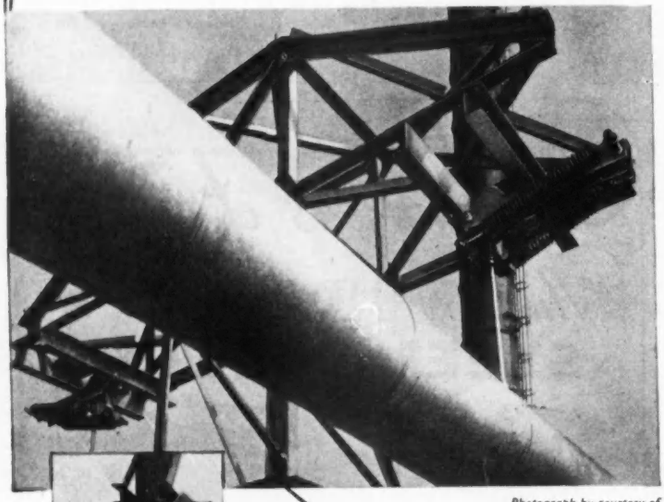

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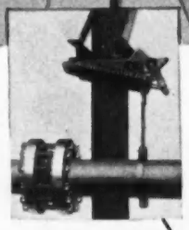

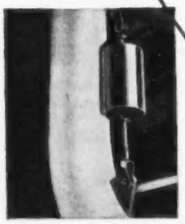

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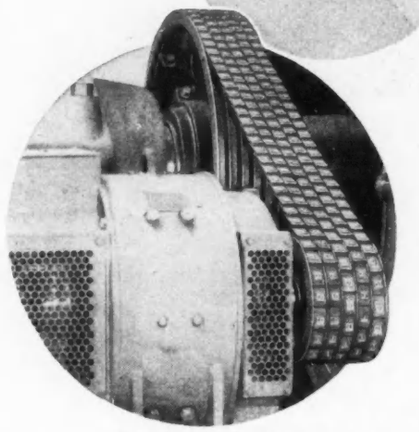

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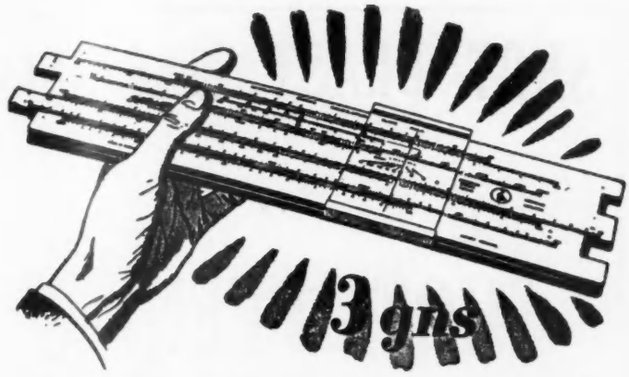

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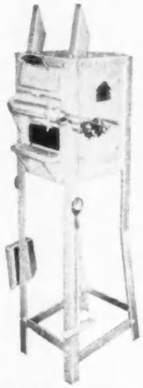

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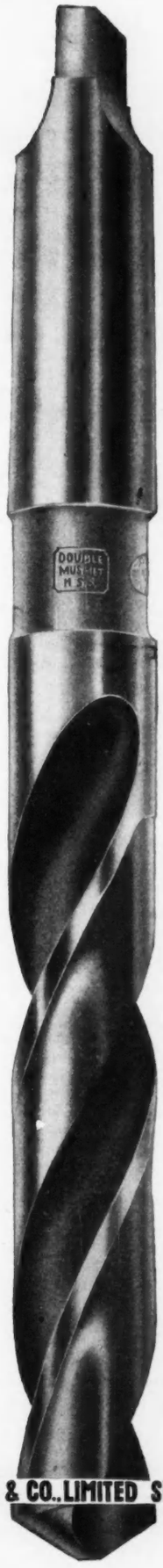

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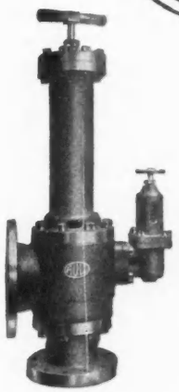

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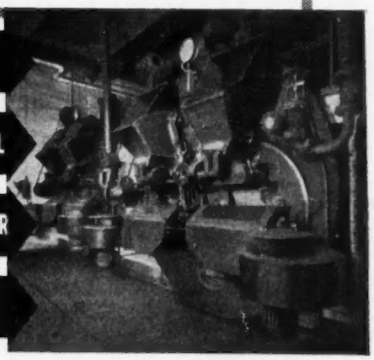

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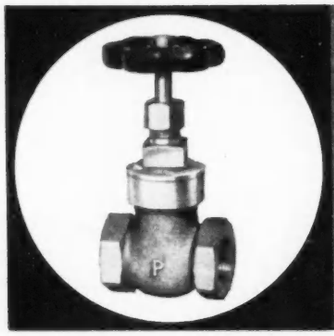

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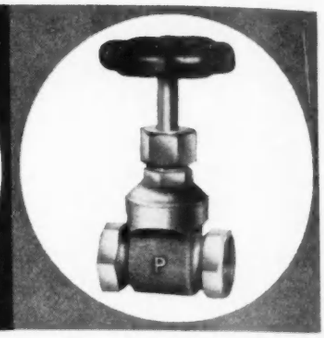

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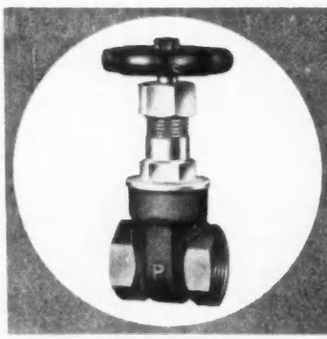

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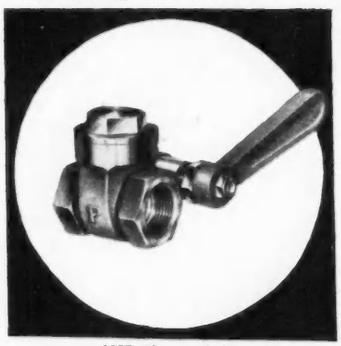

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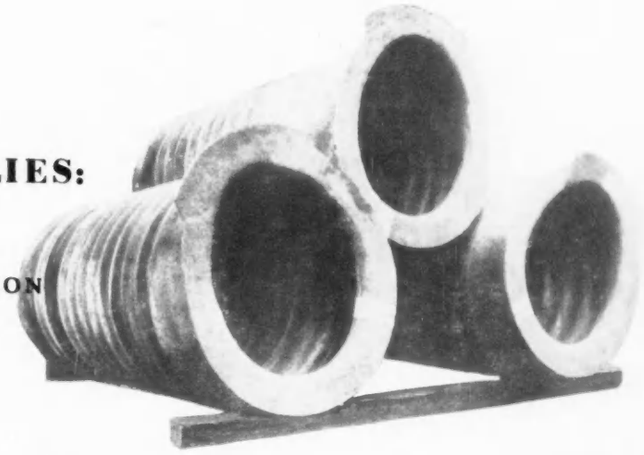

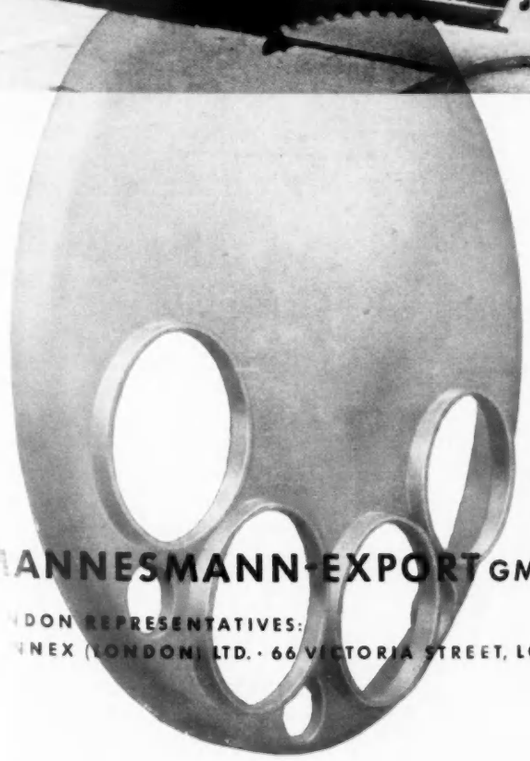

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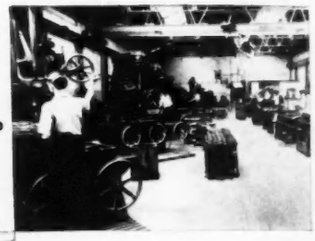

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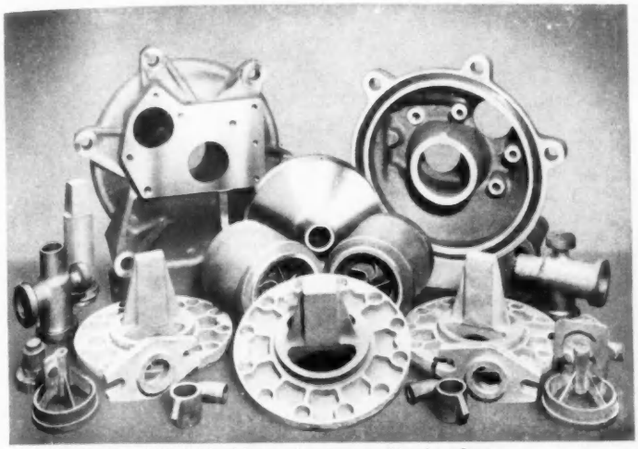

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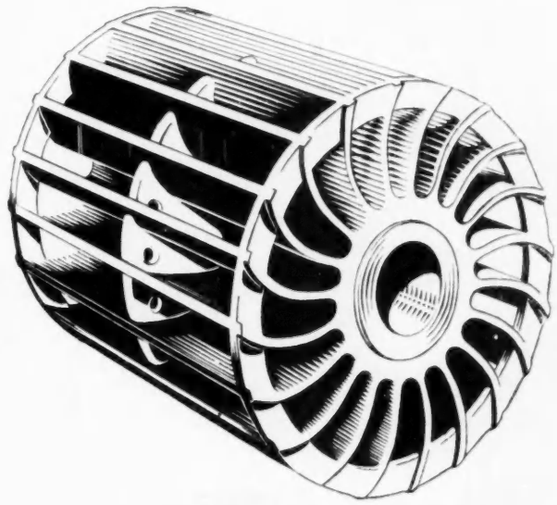

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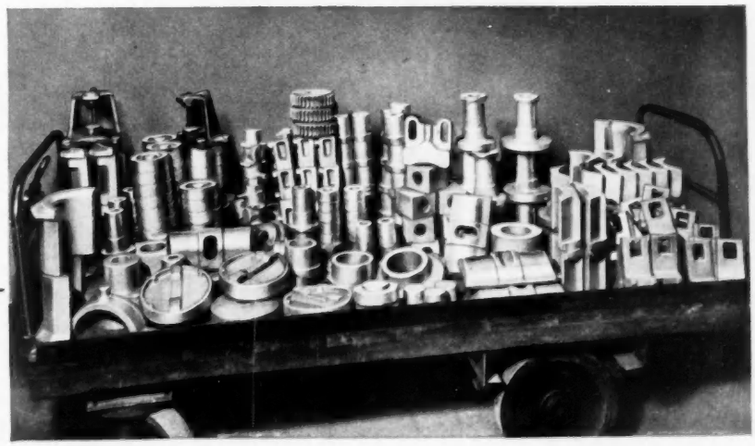

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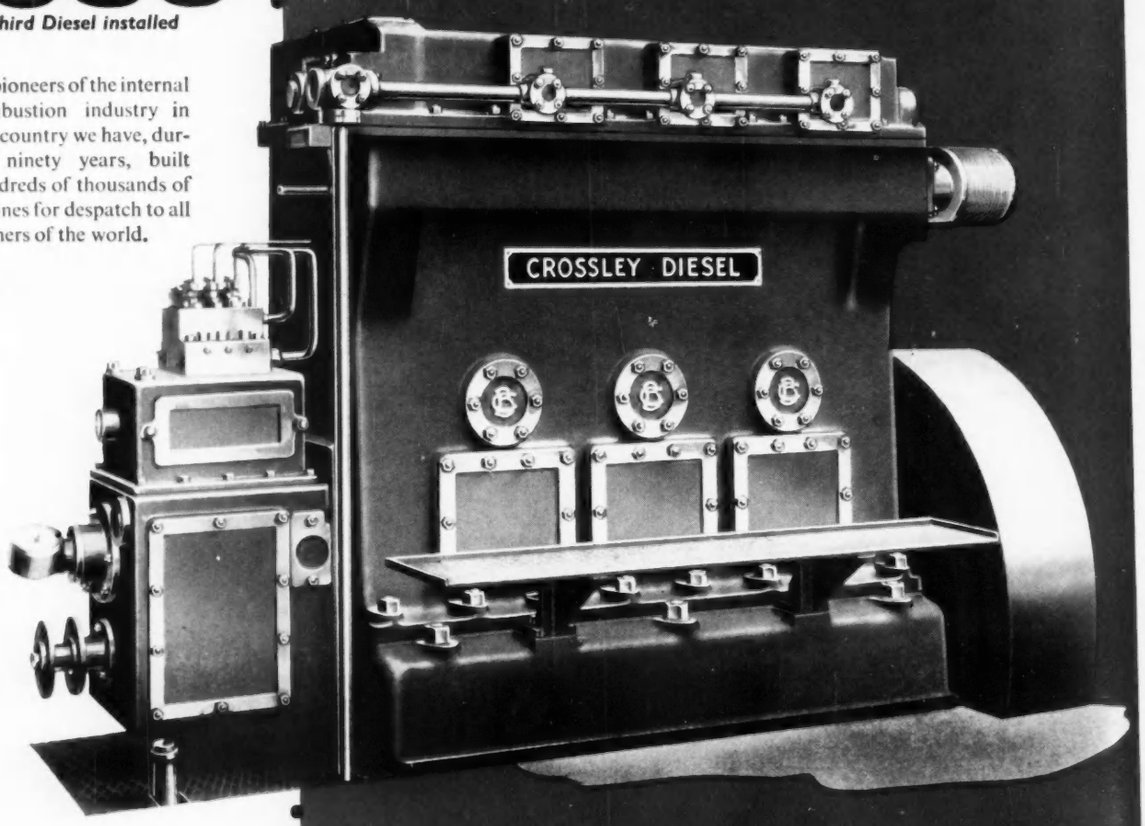

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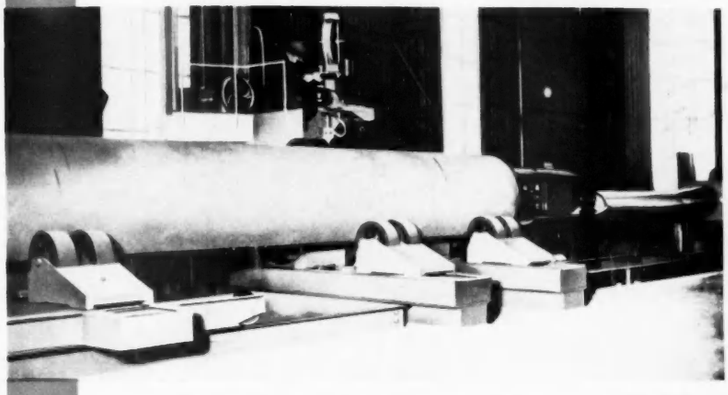

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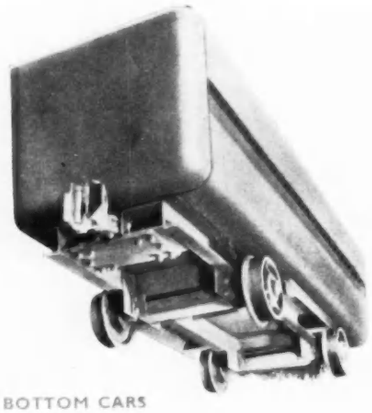
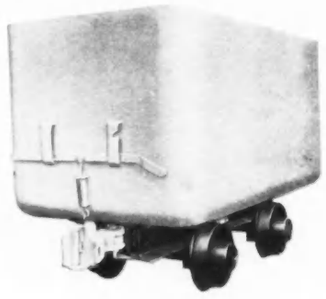
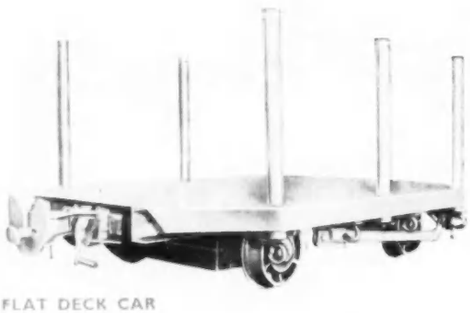


SOLID BOTTOM CARS





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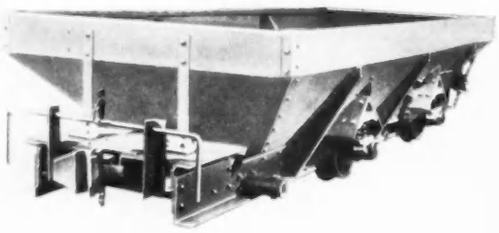
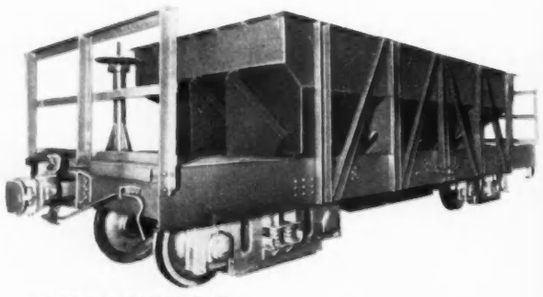
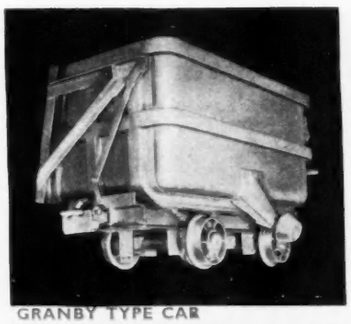
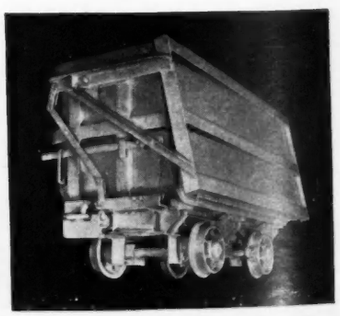


AUTOMATIC DROP-BOTTOM CAR

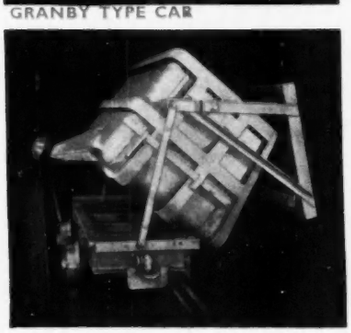


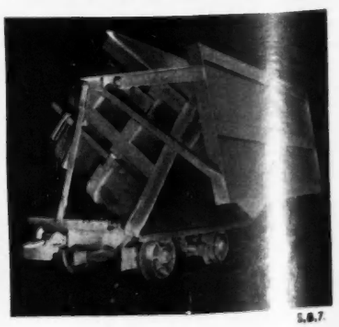
BOTTOM DUMP CAR





GRANBY TYPE CAR





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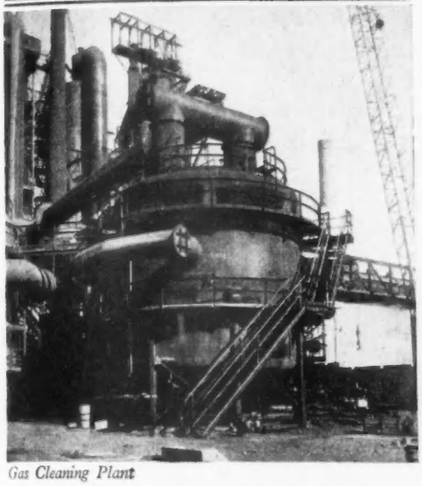

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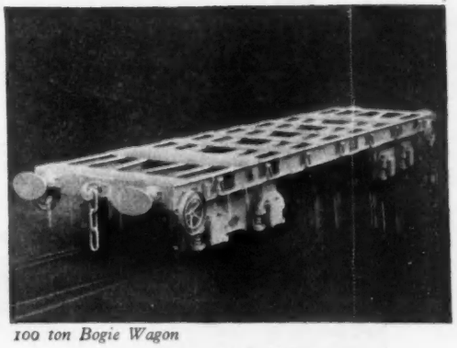

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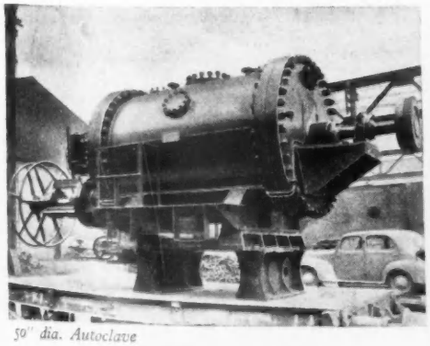

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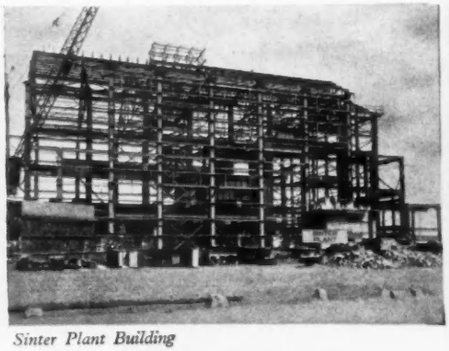

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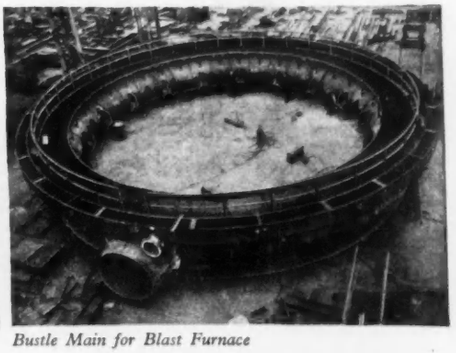

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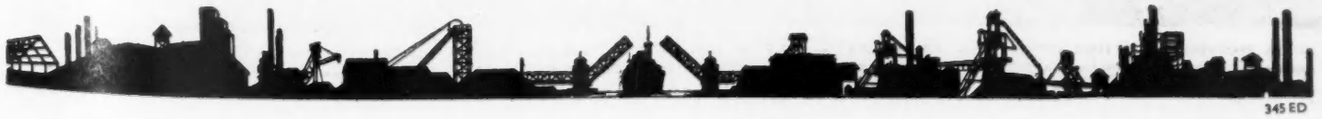

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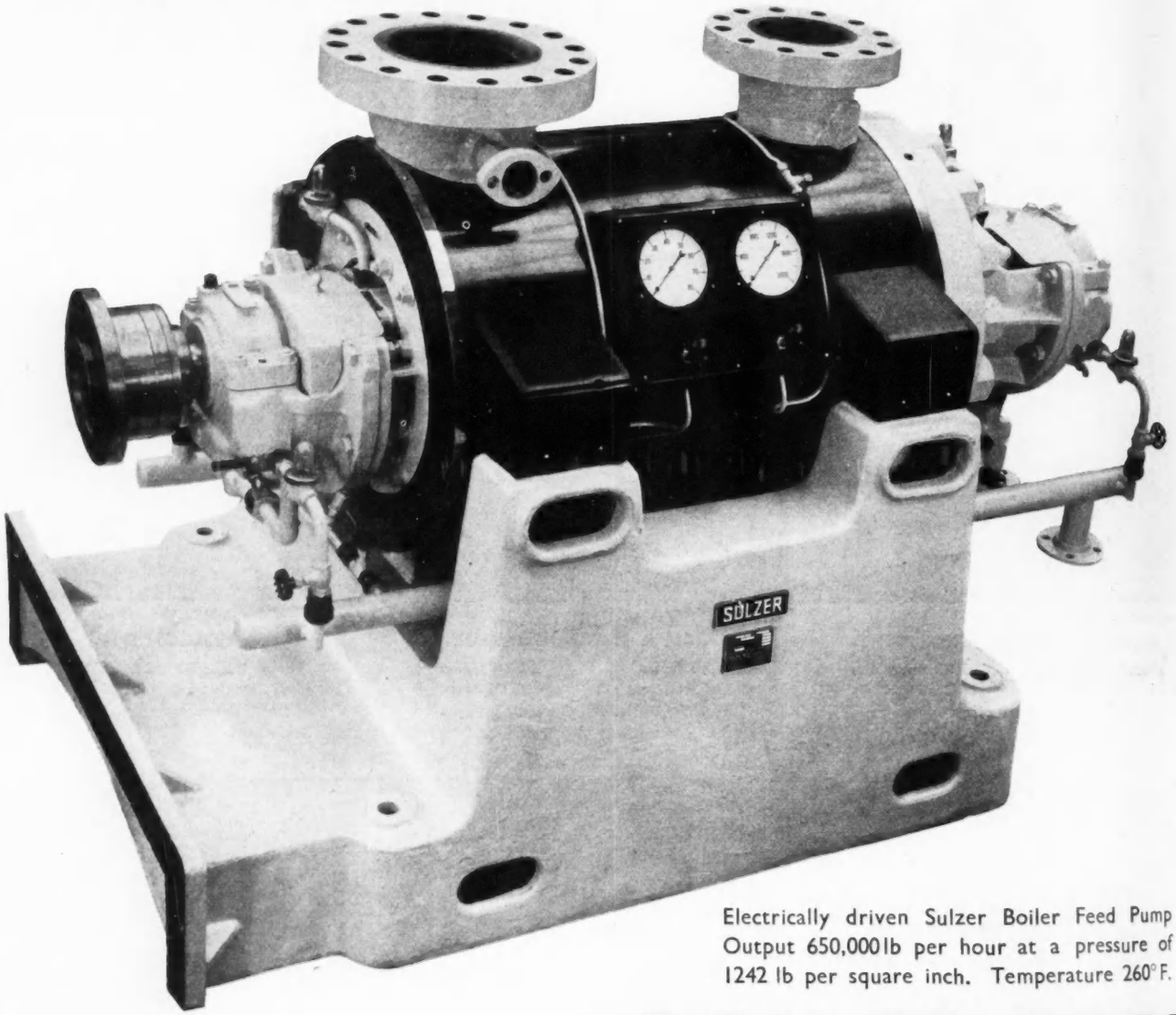

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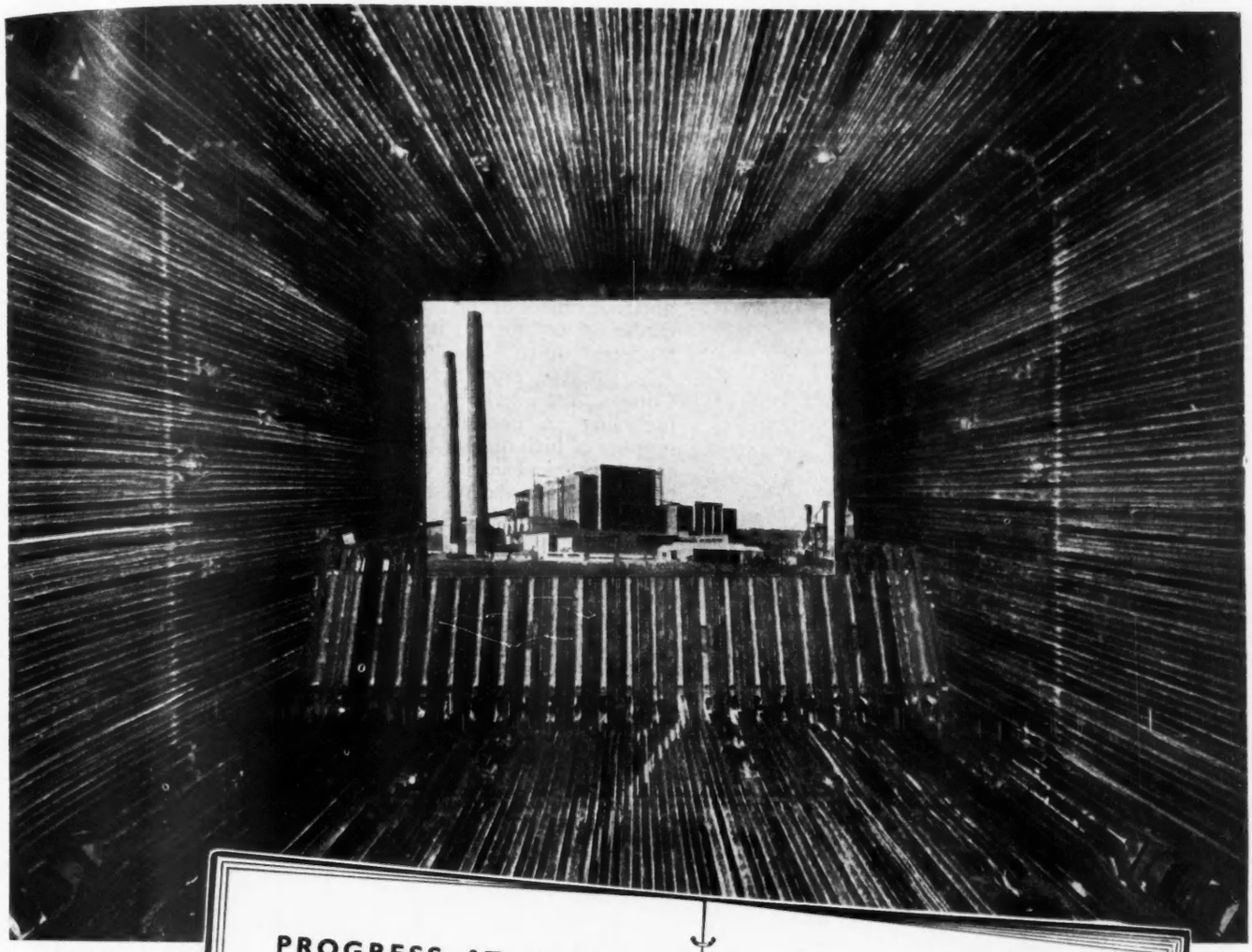

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ENGINEERING

An Illustrated Weekly Journal

Vol. 181 No. 4696 JANUARY 27, 1956

Leading Article

Engineers for the Mines 97

Weekly Survey

American Venture on Clydeside 98
Volkswagen and the 40 hour Week 98
Tanks Without Guns 98
Inflation in the Air 98

Principal Articles

Royal Visit to Nigeria: Engineering in a Fast Developing Country 100
The Engineering Outlook—3: Coal and Electricity: Mining Machinery, Boilers and Heavy Electrical Plant 101
Effect of Leakage Past a Piston: Experiments with a Motored Two-Stroke Engine 104
Reduction Gearing for Ships: Design Criteria and Principles of Manufacture 107
Variable-Speed Motor Control 110

Obituary

Mr. E. S. Byng 99
Mr. C. R. Davis 99

Notes

Index to "Engineering" 97
Waterways Improvements 99
A Practical War Memorial 112
New Reactors at Harwell 112

The Human Element 112

Personal 99, Commercial 99, Contracts 99, Notices of Meetings 111, Forthcoming Exhibitions and Conferences 111

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INDEX TO "ENGINEERING"

Front Cover Photographs Preserved

The photographs used on the front covers of ENGINEERING have aroused considerable interest since they were introduced some years ago. In order to ensure that they are not lost when a volume of the editorial pages is bound, the six-monthly index is now printed with the front-cover photographs on alternate pages. The first new index, for Volume 179, January to June, 1955, is now available without charge from the Publishers, ENGINEERING, 35 and 36 Bedford-street, Strand, London, W.C.2. Readers already on the mailing list need not re-apply.

ENGINEERS FOR THE MINES

FEW would question the need in the mines for more first-class engineers—least of all the National Coal Board. The Fleck Committee, reporting last February, pointed out that the industry was, at nationalisation, "backward both in general and technical management," a legacy from the inter-war period when it was starved of technical men and of capital. Since nationalisation, capital has been poured into the mines more liberally than in any other sector of the economy, public or private. Yet output does not rise, recruitment at all levels remains inadequate and wastage of man-power is disturbingly high. A poorer return on capital has rarely been obtained from any major enterprise.

The Fleck Committee called for "a wide technical renaissance," and for "greatly improved methods of management, technical or otherwise." Last week, Mr. H. A. Longden, director general of production of the National Coal Board, read a paper to the Institution of Mining Engineers which throws a glaring light on the industry's central problem: the recruitment of enough able managers and highly qualified engineers to apply modern business methods in the mines and to secure a worthwhile return from the new machines. But perhaps the most striking message—albeit an indirect one—in Mr. Longden's address is to potential recruits: opportunities abound in coalmining for the gifted and the enterprising engineer, whether he is a mining engineer or not.

The Board have set up their own Staff College where training in management will be provided and where men of varying backgrounds will be brought together, to share their experiences in different coalfields and to acquire a broader knowledge of their industry's problems and objectives than has been possible so far. Another innovation is the Central Engineering Establishment at Bretby, where new machines can be developed or existing machines tested and modified to meet infinitely varied conditions.

Gradually, therefore—but at a quickening tempo since the Fleck Committee's report—the Board are taking steps to give their industry a high technical standing and make it attractive to first-class technical men. There seems, however, to be a continuing reluctance to publicise technical achivements and, in general, the progress of mechanisation. Mr. Longden states three basic challenges to present-day mine management: to increase bulk output, to economise in manpower, and to reduce costs of production. These objectives, he contends, can be achieved not merely by intensive mechanisation but by the application of common sense in the day-to-day management of the mines and by paying close attention to detail.

The scope for improvement is nowhere more obvious than at the colliery surface. In 1948 surface labour accounted for 217 out of a total (underground and surface) of 897 man-shifts per thousand tons (M.S.T.). In 1954, it accounted for 180 out of a total 804 M.S.T. At a newly reconstructed colliery it accounted for 89 out of a total of 324 M.S.T. and is expected "normally to be about 100, and certainly not much in excess of this figure." Spectacular reductions in the manpower required have been obtained by "relatively simple and inexpensive modernisation of traffic-handling arrangements at pit top and pit bottom." Layouts which allow a smooth and clear flow of coal, the introduction of semi-automatic or automatic winding, a rigorous review of coal preparation and dirt disposal methods are mentioned as fields where scope exists for increased efficiency and for economy of manpower. Steam-raising is cited as a field where considerable economies of materials are possible. The elimination of heat losses and leakages is suggested as a first step, to be followed by a gradual adoption of plant designed to burn low-grade fuel—one boiler plant is successfully running on pond slurry—until the Board's objective of complete electrification can be achieved.

Mr. Longden has much to say on the methods of handling supplies at collieries, where there is "extensive scope for improving on existing standards of efficiency." Here, as in most other surface activities, the application of thought and logic—in the handling and storing of materials and the issuing of stores, coupled with efficient layouts—will yield substantial economies. Throughout his review, whether in the bundling or palletising of stores or in the planning and use of mechanical handling equipment, Mr. Longden's remarks suggest that the application of efficient business methods and effective supervision are the first necessity and—by implication—that they are sadly lacking. He is more satisfied about coal-face mechanisation and has little to say about it. Its general effect has been "to double productivity compared with previous methods."

The recent announcement that Mr. James Bowman is to become chairman of the Board in August completes the rebuilding of the top management team begun eleven months ago when the Fleck Committee submitted their report. It will be the task of Mr. Bowman and his colleagues to provide the stimulating leadership that is required to effect the "wide technical renaissance."

★ ★ ★ **We offer our apologies to readers, contributors and advertisers for the reduced size of this issue, which is caused by the current dispute in the printing industry.** ★ ★ ★

Weekly Survey

Cover Picture: *The cold rolling of metal strip is usually carried out in four-high reversing rolling mills, fitted on both the entry and exit sides with coiling reels which exert a tension on the strip during rolling. One such reel is shown on our cover; it is fitted with a hydraulically-operated wedge which expands and contracts the reel drum, thus gripping or releasing the strip. The reel can handle a coil weighing up to 1,000 lb., and is driven by a 1,000 h.p. motor. Rolling speeds of 1,000 ft. a minute are employed.*

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American Venture on Clydeside

Belshill, in North Lanarkshire, has for long been a pocket of unemployment on Clydeside. It has suffered from being on the exhausted site of the old iron-ore beds and the North Lanarkshire coal mines which brought the original industrial prosperity to the Clyde basin. The area has badly needed new industries for a generation or more; even the recent prosperity of the steel industry in the area has not greatly reduced the problem, which is basically one of diversification.

Last week, the American Caterpillar Tractor Company announced that it would establish its first overseas factory at Belshill. The British Treasury apparently offered to advance part of the capital for the site and buildings but the company has preferred to use its own resources and private borrowing. Work on the new factory is to begin in the middle of 1956 and production is planned to start in 1958. At first, the large D8 Diesel tractor, used for heavy construction and earthmoving, will be produced. This will be followed by the D4, which is used in agriculture, in open-cast mining and in light construction work. Eventually, a major part of the Caterpillar range, which includes Diesel engines, bulldozers, excavators, pipe-layers and motor graders will be manufactured. Employment will be given at first to 1,500 men. The output of the new factory will be based on the technical resources of the parent company and it will be given rights in all patents, processes and copyrights. The tractors will sell in competition with all other units made by the group throughout the world. Apprenticeship schemes will be introduced to train labour.

One more American company has thus gone to Clydeside for its manpower in an effort to take advantage of the lower wage rates in this country compared with the United States. The project is a major gain for Scottish industry. It prompts the thought, nevertheless, that such developments (another possible scheme mentioned in these notes last week was car manufacture) cannot go on indefinitely, despite existing pools of unskilled labour, without affecting the labour force of the traditional engineering industries in the area.

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Volkswagen and the 40 hour Week

The progress of Volkswagen G.m.b.H. of Wolfsburg has excited considerable interest over the last few years, and the second post-war progress report just published by the company reveals indeed a remarkable record. During the period 1951 to 1954, output of cars and commercial vehicles rose by 128 per cent., home sales by 95 per cent. and exports by 203 per cent.

Although sales at home and abroad increased substantially, an increasingly higher proportion was in the export market. One of the main reasons given for this success abroad is the policy of maintaining substantial stocks of spares and efficient servicing arrangements. This service backs up a world-wide sales organisation which consisted at the end of 1954 of 106 general importers and 2,187 concessionnaires. In addition, subsidiary assembling companies have been established in many countries. After the 1952 Motor Show in Toronto it was decided to establish assembly plants in Canada and Brazil, but it has been the U.S. assembly plant (started in 1950) which has attracted most attention. In 1950, only 330 units were sold to the U.S.A., but by the end of 1955, the report estimates that 42,000 were on the roads of the United States. In November last, the company announced that it had bought the Studebaker-Packard factory in New Jersey, which would help towards producing a target figure of 75,000 cars a year for the U.S. market. Volkswagen have also succeeded in penetrating the U.K. domestic market, which until 1953 was closed to them; last year Britain imported 3,260 Volkswagens. U.K. manufacturers are finding it increasingly difficult to hold their European markets against the German car.

Last week, there came the announcement that a 40 hour week for Volkswagen workers is now in sight. This is a radical reversal of the forecast made by Dr. Nordhoff, the general manager of the company, last August when he expressed doubts as to whether the German Federation of Trade Unions would ever get their demand for a 40 hour week granted. A growing shortage of labour in Germany, increasing demands for higher wages and a shorter working week may well force costs up in a period in which foreign markets will become increasingly subject to competition. Mild inflation has begun to appear in Germany as full employment is reached. German car manufacturers may therefore soon experience the same sort of squeeze on profits margins as those in this country have done. But the German boom is about 12 months behind the British one, measured in terms of full employment and inflation—and that gap could still give the Germans a critical advantage.

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Tanks Without Guns

Disposing of surplus war materials to private traders after a war is a major trading activity. In the ten years between 1945 and 1955 the Government sold £478 million worth of surplus stores and equipment in the United Kingdom and £299 million worth abroad. This excludes £33 million worth of surplus goods sold in that period by the Admiralty in the United Kingdom. Although elaborate precautions were taken towards the close of the war (compared with the rough and tumble which took place in 1918) to ensure an orderly disposal of these masses of obsolete and obsolescent equipment, it would be surprising if there were no administrative blunders in the large number of transactions which figures of this size represent. There were one or two lurid examples of profiteering a few years ago but it has taken the delicate political situation in the Middle East to bring the disposals procedure and export control of these surpluses under review by White Paper. In the event the political and diplomatic boats have been rocked by between 50 and 100 obsolete Sherman tanks minus breech blocks, exported to Israel via France, and 151 Valentine self-propelled mountings minus breech blocks exported to Egypt via Belgium.

The White Paper (Cmd. 9676) deprecates the fact that war surplus material from this country has indirectly found its way to the Middle East, but it is satisfied that the material was small in quantity and obsolete and that it has not disturbed the balance of power between Israel and Egypt. It is quite clear from the White Paper that there has been a certain amount of administrative slackness amounting to naïvité in Whitehall, in interpreting regulations governing the sale of war surpluses, and it is also clear that there has been a lack of liaison between the United Kingdom Government and certain others in Western Europe.

One of the most confusing issues of all is the question of demilitarisation of the equipment. It may be assumed that neither the Israeli nor the Egyptian Governments were anxious to buy obsolete equipment without breech blocks in the one case, and without armaments in the other—although the possibility cannot be ruled out that each expected to gain some advantage over the other by parading, Chinese fashion, harmless scrap metal on crawler tracks along the other's frontier. Nor would it be wise to ignore the fact that although neither side is equipped to manufacture breech blocks, both, particularly the Egyptians, must have access to war stores acquired in one way or another between 1939 and 1945. It must be presumed, therefore, until it is proved to the contrary, that both sides bought this obsolete equipment in order to possess armoured offensive weapons, no matter how obsolete by American or British standards. That being the case, the possibility of further demilitarisation of such equipment which is sold for scrap should be thoroughly examined. The delicate balance of power in the Middle East so far as armaments are concerned must not be left only to the working of administrative machines, no matter how efficient they may claim to be for the future.

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Inflation in the Air

Last week was remarkable for the amount of ink which was used in reporting verbal attacks on inflation. The Prime Minster's speech at Bradford dealt largely with home affairs. The Government's determination to use further weapons in the fight against inflation, if that should prove necessary, was probably the most important point which came out of the speech. By coincidence, the season for the bank chairmens' speeches also opened. The first of the chairmen to offer an opinion on the present health of the economy emphasised the need to reduce Government expenditure, and this theme has been common to the others who have followed. Some of the chairmen have thought that the credit squeeze has not yet been sufficient to bring inflation under control, and doubts have been expressed on the Government's policy to use exhortation rather than a more extreme form of monetary stringency. It will be interesting to see if those chairmen's speeches which have still to come show any signs of being redrafted at the last minute to take account of such recent developments as the shorter working week in sections of the motor-car industry.

The Federation of British Industries have also expressed their views on the state of the nation in a memorandum addressed to the Chancellor of the Exchequer on this year's Budget. The F.B.I. calls for an "absolute cut in public spending." They go on to say that although the monetary and fiscal measures which the Government have adopted to check the present inflationary trend have already had some significant effects, they have not dispelled the threat of further inflation.

Timing is now the most critical factor in the effort to curb inflation. There is no doubt that the credit squeeze is beginning to have some effect. The motor-car industry, which is probably capable of affecting the industrial climate more quickly than any other industry in the country, is now reducing working hours and the first gestures have been made, however ill-conceived in their own context, by shop stewards to reduce overtime in the industry. It is just possible that there is now enough monetary pressure, if it is sustained, to reduce overtime earnings in a wide section of industry (for overtime earnings play an important part in swelling the public's purchasing power). Such a reduction, in addition to the disincentive to hold large stocks of raw materials and to slow down investment might yet be enough to keep prices stable. On the other hand such events as the coming increase in railway wages are bound to raise transport costs. It is known that transport, along with food and entertainment are the main sources of inflationary pressure so far as expenditure by the public is concerned. Altogether, combatting inflation is now a very nice calculation of the less or more, and no one will envy Mr. Harold Macmillan his task of formulating his April Budget.

PERSONAL

The first award of the William Froude Gold Medal has been made by the Institution of Naval Architects, 10 Upper Belgrave-street, London, S.W.1, to Emeritus Professor Sir Thomas H. Havelock, M.A., D.Sc., F.R.S.

Mr. E. S. Endicott, managing director of Ruston-Bucyrus Ltd., has succeeded Mr. D. C. Bean, a director of the British Steel Piling Co. Ltd., as President of the Federation of Manufacturers of Contractors' Plant, 121 Queen Victoria-street, London, E.C.4. Mr. G. A. Hannah, managing director of Pegson Ltd., has been appointed vice-president.

Mr. L. C. Jesty, B.Sc., M.I.E.E., F.T.S., chief of the television research group of the research laboratories of Marconi's Wireless Telegraph Co. Ltd., at Great Baddow, has been elected a Fellow of the Institute of Radio Engineers, New York "for leadership and personal contributions in the development and evaluation of television systems."

Mr. James Bowman, C.B.E., J.P., has been appointed to succeed Sir Hubert Houldsworth, Bt., Q.C., as chairman of the National Coal Board when Sir Hubert's term of appointment expires on July 31. Mr. J. Latham, C.B.E., has also been appointed to succeed Mr. Bowman as deputy chairman of the Board from the same date.

Mr. J. Singleton-Green, M.Sc., M.I.C.E., M.I.Struct.E., A.M.I.Mech.E., has been elected chairman of the Prestressed Concrete Development Group of the Cement and Concrete Association.

Mr. J. R. Brinkley has been appointed managing director of Pye Telecommunications Ltd., Cambridge, and an executive director of Pye Ltd.

Under the Royal Society and Nuffield Foundation Commonwealth Bursaries Scheme, awards have been made to members of the staffs of universities of the Commonwealth to enable them to undertake research tasks in other parts of the Commonwealth. These include Dr. H. B. S. Cooke, Witwatersrand (geology); Mr. R. G. Cooke, Melbourne (organic chemistry); G. C. Israel, Hong Kong (physical chemistry); Professor L. C. King, Natal (geology); Dr. K. G. McNeill, Glasgow (natural philosophy); and Dr. A. Bose, reader in physics at the Indian Association for the Cultivation of Science, Calcutta.

The position of works manager at the factory of Simms Motor Units Ltd., vacant for some time, has now been filled by Mr. H. R. Daddow, who has been assistant works manager of the plant since March, 1955.

Mr. B. R. Cant has been appointed general works manager, the National Gas and Oil Engine Co. Ltd., Ashton-under-Lyne, as from January 30. Mr. S. Cooper has been appointed to succeed Mr. Cant as works manager, J. and H. McLaren Ltd., Leeds.

Mr. A. N. Wormleighton, joint managing director of the Phosphor Bronze Co. Ltd., has resigned the chairmanship of the National Foundry Craft Training Centre's Management Committee, owing to increasing pressure of business, but remains a member of the Committee. His successor as chairman is Mr. J. Hird, works manager of Rudge Littley Ltd., West Bromwich.

Mr. C. B. Morton, D.S.O., M.B.E., D.F.C., has been appointed general manager of Spiro-Gills Ltd., London-road, Pulborough, Sussex.

Mr. Roy Simmonds, lecturer at the Derby and District College of Technology, is to take up an appointment at the new Royal Technical College of East Africa, Nairobi. He will be senior lecturer in electrical engineering and deputy head of the Engineering Department of the College.

Mr. D. W. Burnand, B.Sc., A.M.I.E.E., has been appointed sales manager of the electrical division of Wakefield-Dick Industrial Oils Ltd.

Mr. C. W. Wiles has been appointed manager of the London office of Thompson Bros. (Bilston) Ltd., following the retirement of Mr. A. J. Lowe after 36 years of service as manager.

Mr. P. F. Dilnot, M.I.Mar.E., has joined the staff of Ruston & Hornsby Ltd., Lincoln, as assistant marine sales manager. Mr Dilnot was formerly on the staff of the Engineer-in-Chief of the Fleet at the Admiralty.

Mr. K. F. Dowell, A.R.Ae.S., has joined the technical sales department of Smiths Aircraft Instruments Ltd., Kidlewood, London, N.W.2, as a senior sales representative dealing with automatic pilots, flight systems and radio navigation instrumentation.

Mr. E. D. Etherburn has been appointed technical representative for Edgar Allen & Co. Ltd., Sheffield, 9, for engineering tools and tool steels for Lancashire, Cheshire, Westmorland and Cumberland. Mr. L. J. Etheridge has been appointed to a similar post covering the Midlands and Lincolnshire.

Mr. E. J. Mercer, managing director of Allis-Chalmers Great Britain Ltd., Essendine, Stamford, Lincolnshire, since 1953, has been appointed general manager of the construction machinery division, Allis-Chalmers Manufacturing Co., Milwaukee, U.S.A.

Mr. J. D. Markland, M.I.E.E., Assoc.I.Mech.E., has been appointed home sales manager of the Hotpoint Electric Appliance Co. Ltd., Peterborough.

Mr. S. M. Aisenstein has retired from the position of general manager of the English Electric Valve Co., Waterhouse-lane, Chelmsford, Essex. His successor is his deputy, Mr. A. J. Young.

The Yale and Towne Manufacturing Co., British Materials Handling Division, have appointed Mr. R. H. Matthews and Mr. K. A. Lloyd, previously sales engineers, to be area sales managers. The former will cover the London region, the Home Counties, East Anglia and part of the West Country, and Mr. Lloyd, the East and West Midlands and North Staffordshire.

Mr. H. Rosson has been appointed commercial manager of the associate company of Croda Ltd., Croda House, Snaith, Goole, Yorkshire, in Italy, namely, Croda Italiana S.r.l.

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COMMERCIAL

The Caterpillar Tractor Co. Ltd., Desford, Leicester, has announced a project to manufacture crawler tractors in the United Kingdom. Heretofore the activities of this subsidiary company of the Caterpillar Tractor Co., of the United States, have been confined to the provision of replacement parts. For the new manufacturing project, a factory is to be built in Glasgow, and the British firm will be given rights to make and sell all the regular products o the parent company.

Borax Consolidated, Ltd., and A. Boake, Roberts & Co. Ltd., announce their association in the production and marketing of organic boron compounds. Inquiries for samples and prices should be addressed to Borax Consolidated, Ltd., Borax House, Carlisle-place, London, S.W.1. (Telephone: VICtoria 9070.)

The name of British Petroleum Chemicals Ltd. has been changed to British Hydrocarbon Chemicals Ltd., Grangemouth, Stirlingshire. The firm is owned by the British Petroleum Co. Ltd., and the Distillers Co. Ltd.

The Dunlop Rubber Co. Ltd. have completed plans for the manufacture, in Malaya, of their Dunlopillo latex foam products. The equipment of a factory at Bahau in Negri Sembilan is well advanced and production is expected to commence within a few months.

Following the decision to separate the Steel Company of Wales Ltd., from Richard Thomas and Baldwins Ltd., Mr. Colin Hurry, 17, Great Queen-street, Kingsway, London, W.C.2, is to resume his function of London Press liaison for the Steel Co. of Wales. The South Wales office continues under the management of Mr. Godfrey Walker, the company's information officer, at Abbey Works, Port Talbot.

British Carbo Norit Union Ltd., London, and Whessoe Ltd., Darlington, have made an agreement for the supply of Carbo-Union-Whessoe recovery plant for the purification of gases and the recovery of vapour-phase solvents. These plants are used extensively in the gas, rubber, printing, plastic, artificial-silk and dry-cleaning industries to recover valuable products and solvents.

Bristol Aircraft Ltd. have formed a new major department responsible for all engineering servicing and training on Bristol aircraft, with special emphasis on the Britannia. The new department is a development of the former service organisation and will be headed by Mr. J. C. Harrington, O.B.E., F.R.G.S., M.Inst.T., formerly deputy operations director (operations) of the British Overseas Airways Corporation, who now joins Bristol Aircraft Ltd. as general service manager.

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CONTRACTS

Dynamometer. An order has been received from Tampella Oy, Finland, by Heenan and Froude Ltd., Worcester, for a Mark VII Heenan Dynamatic dynamometer having a maximum capacity of 2,100 b.h.p. The machine will be used to test complete propulsion units for Diesel-hydraulic locomotives. In September, 1955, Tampella Oy received a contract to build 16 of these units, each of 800 b.h.p., to be made under licence from the M.A.N., Augsburg, complete with torque converters made under Swedish licence.

Cargo Motorship. The Alexander Shipping Co. Ltd. (Houlder Brothers & Co. Ltd.—managers), London, have placed an order with the Burntisland Shipbuilding Co. Ltd., Burntisland, Fife, for a single-screw cargo motorship of 12,000 tons deadweight carrying capacity. The principal dimensions are: length, between perpendiculars, 430 ft., breadth 61 ft. 9 in., and depth moulded to upper deck 38 ft. 3 in. The propelling machinery will be fitted amidships and will consist of a 5,500-b.h.p. Hawthorn-Doxford type Diesel engine constructed by Hawthorn-Leslie (Engineers) Ltd., Newcastle-upon-Tyne.

Broadcasting Transmitters. The Norwegian Telegraph Administration have placed an order with Marconi's Wireless Telegraph Co. Ltd., Chelmsford, Essex, for 11 of their 5 kW frequency-modulated very-high-frequency broadcasting transmitters and a quantity of phasing equipment. The simplicity in operation of the new transmitters will make them particularly suitable for unattended working.

Air Liners. Air Austria Luftfahrts, officially founded on January 9, have announced in Vienna that they have ordered four Vickers Viscount 800 series propeller-turbine air liners. Vickers-Armstrongs Ltd., Vickers House, Broadway, London, S.W.1, state that these aircraft, which are due for delivery at the end of 1957, will be of type V.803 and similar to the nine Viscounts already ordered by K.L.M.

Wreck Raising. The task of raising the Cyprian Coast has been allotted by the Tyne Commissioners to Metal Industries (Salvage) Ltd., Faslane, Dunbartonshire. This vessel, owned by the Tyne-Tees Shipping Co. sank off Newcastle Quay following a collision with the Swedish ship Arabert on December 23, and now lies, an obstruction and danger to shipping, on her side in the fairway.

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WATERWAYS IMPROVEMENTS

Last week the British Transport Commission announced that they intended to spend £5½ million on improvements to certain of the inland waterways. The principal work to be undertaken includes better bank protection, the removal of bottlenecks such as small locks, the reconstruction of certain weirs and sluices, and the provision of new dredging craft. The canals affected and the mileages concerned are as follow: Aire and Calder Navigation (62½), Sheffield and South Yorkshire Navigation (43¼), River Trent (68¾), River Weaver (20), Grand Union Canal (south Berkhamsted) (57¼), River Lee (below Enfield Lock) (14¼), and River Severn (including Gloucester/Berkeley Canal) (59¼). At present it is intended to complete the schedule of work in the next five years, subject to Government curtailment of capital expenditure.

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Obituary

MR. E. S. BYNG

We regret to record the death of Mr. E. S. Byng, which occurred, at the age of 72, at Purley, Surrey on January 13. He was well known in connection with the development of international telecommunication and especially for the part he played in advocating the wider education of engineers. He was appointed managing director of Standard Telephones and Cables, Limited, in 1928 and became vice-chairman in 1933.

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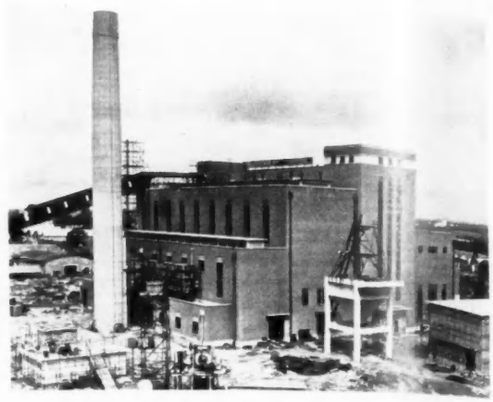
MR. C. R. DAVIS

It is with regret that we note the death of Mr. Carl Raymond Davis which occurred in Cape Town, South Africa, on January 16. Mr. Davis, who had just entered his 83rd year, had spent all his active life in the profession of mining engineering and was for many years technical director and a London agent of the Anglo-American Corporation of South Africa, Limited.

Apapa Wharf, costing £4½ million, built on 100 acres of reclaimed land.



Ijora "B," built wholly on a flotation raft.

ROYAL VISIT TO NIGERIA

ENGINEERING IN A FAST DEVELOPING COUNTRY

Nigeria, which is to be visited by the Queen and the Duke of Edinburgh from January 28 to February 16, is the largest of the United Kingdom dependencies. It has an area of 375,250 sq. miles, which is greater than that of France and Italy combined. The population is estimated at some 32 million, made up of a large number of tribal groups, of whose educational and industrial advancement the Royal visitors will see many signs.

The country is divided into three parts by the River Niger and its tributary the Benue. The Niger is navigable upstream for 537 miles and the River Benue for 547 miles, and these with other navigable rivers form important alternatives to the railways, which are far from serving the whole of the country. From the two chief ports, Lagos and Port Harcourt, the railways penetrate as far north as Kaduna and Kano. There are 2,022 miles of bituminous roads, 22,600 miles of all-weather gravel or earth roads and 7,364 miles of dry-season earth roads. All these means of communication are relatively inadequate for a country the size of Nigeria and it is for this reason that Her Majesty's journeys inside the country will be made by air. The West African Airways Corporation maintain internal and international services, using international airports at Lagos and Kano and 15 other airfields.

Her Majesty is to open two power stations and a port extension, and will visit a college of science and technology. The material and intellectual advance of any nation is so directly dependent on engineering and its works that these items in the programme may be looked upon as among the most important.

Two-thirds of the exports of Nigeria (mainly cocoa, tin, timber, palm oil and ground nuts) pass through Lagos, as well as much of the import trade which is increasing with the expanding economy of the country. The volume of imports has doubled in ten years. Pressure on wharf accommodation at Lagos has been felt for some years; a common sight has been a long queue of ships anchored in the roadstead. The first Apapa Wharf at the Port was completed in 1928. It is 1,800 ft. long and provides for four ships. This proving inadequate, the Nigerian Government instructed Coode and Partners to prepare plans for a 2,565 ft. extension for five ships. Work on the project is now complete and the wharf will be opened by the Queen on February 10. The main contractors for the wharf and ancillary works were Richard Costain, Limited.

The most important feature of the new works is the wharf wall. An area beyond the existing wharf and sheds had to be reclaimed to form the site of the extension. Filling material was won by a suction dredger discharging into barges which were then towed to a stationary reclamation dredger, whence the material was pumped ashore through a short land pipe-line.

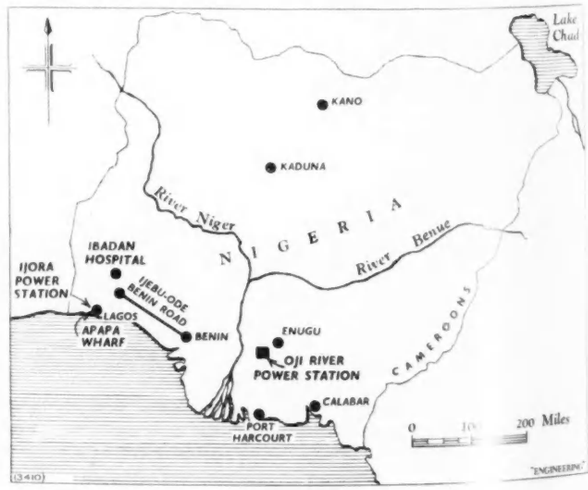
Civil engineering works carried out by Richard Costain Limited also comprised Ijora "B" and the Oji River power stations and the University College Hospital at Ibadan. Ijora "B" power station, which will be officially opened by the Queen on February 10, has been built alongside the old "A" station. The site is near Lagos and the new station, in common with the old, will supply power to that town. Initially, the station will contain two 12,500 kW units, but it is planned for an ultimate capacity of 85,000 kW. The station will be coal fired, the fuel being obtained from Enugu, by rail to Port Harcourt and thence by sea (Enugu is at present the only coal-producing district in Nigeria). The station is a steel-framed builing with hollow blockwork walls. The site is a reclaimed swamp with a ground level only 8 ft. above sea level. The depth of bad material is so great that piled foundations could not be employed; the station therefore stands on a concrete raft 45,000 sq. ft. in area and containing 2,500 tons of steel and 22,300 cub. yd. of concrete. The consultant for the civil engineering work are Coode and Partners, and for mechanical and electrical equipment, Preece, Cardew and Rider.

The Oji River power station, to be opened by Her Majesty on February 9, is situated near Enugu, which lies some 200 miles up country from Port Harcourt. It will supply power to that town and to the surrounding country. The Oji is a small river which flows into the Niger and which even in the dry season will supply adequate cooling water. The main part of the station is a steel frame covered with asbestos sheets, but the offices and switch house are of concrete-block construction. The station will initially have a capacity of 10,000 kW generated by two sets, but is designed for an ultimate capacity of 30,000 kW. Coal is obtained from the Enugu mines and is transported to the station stacking area by an aerial ropeway which passes through 16 miles of wooded and hilly bush country. The consultants for this station are the same as for Ijora "B."

Her Majesty's visit to Ibadan will enable her to see something of the educational activities of the country. She is to visit University College which was incorporated by Ordinance in 1948. New buildings including two halls of residence were opened in 1952. There is an Institute of Economic and Social Research and a Department of Extra-Mural Studies. Courses in arts, science, medicine and architecture are held. In 1953-54 there were 406 students and a staff of 113.

A visit will also be made to the Ibadan Branch of the Nigerian College of Arts, Science and Technology. This institution has branches at Enugu and Zaria, which lies some 40 miles north of Kaduna. It has been allocated £900,000 from United Kingdom Colonial Development Funds. It provides technical education at the highest level short of university standard, and there are some 750 students taking courses. It is intended that a college diploma in engineering shall be instituted and others may follow. Students at present sit for the examinations of the City and Guilds of London Institute and the Royal Society of Arts. The students of the University College of Ibadan work for University of London degrees.

Apart from activities within Nigeria the intellectual and technical level of the country is being raised by students attending universities in the United Kingdom and the Irish Republic. Many are assisted by scholarships but some come as private students and maintain themselves. The total number from all colonial dependencies in the academic year 1954-55 was 10,266; of these 2,782 came from Nigeria. In the numbers taking specific subjects, engineering ranks third with 1,160, but what proportion of them are from Nigeria is not stated.



The Engineering Outlook—3

COAL AND ELECTRICITY

MINING MACHINERY, BOILERS AND HEAVY ELECTRICAL PLANT

Long-term prospects are particularly relevant for those sections of the engineering industry which serve coal and electricity. In these days of far-ahead programmes and planning, the outlook, especially in the home market, for mining machinery, heavy electrical equipment and boilers for the next year or two has already been established—apart from small modifications—by expansion programmes based on estimates of demand for coal and electricity made in the early 1950's. Planning for coal and electric power is now going on for the late 1960's and 1970's.

It is evident, in such circumstances, that the important factor influencing the forecasts for 1956 is the impact on these plans of the availability of nuclear power in the next decade. We could still say in this article of the series a year ago that the immediate problem was to raise as much coal as possible, use it as economically as possible and use power from fuel oil to close the rest of the gap between supply and potential demand before atomic energy began to make a significant contribution to the supply of power in the 1970's. By a coincidence, this article in last year's series was published only a week or so before the issue of the Government White Paper (Cmd. 9389) on atomic energy for electrical generation. The effect of that White Paper has been to speed up the time-table although it has not basically altered the "immediate problem," as it was called at the time.

The fact, however, that the time-table has been brought forward by 10 years has one important implication for the mining machinery industry. It brings closer the day when the coal industry and those who work in it and serve it must face this question: will this country need as much coal for fuel for an indefinite period as can be raised by the maximum investment programme irrespective of the trend of costs, or does the arrival of atomic power for industry on a large scale mean a gradual changeover of the coal industry to becoming, say, largely a producer of raw material for organic chemicals?

There was a good deal of controversy on this question in 1955. Broadly speaking, opinion early in the year was moving in favour of the second alternative but it veered back towards the first one (that coal will remain the major source of fuel and energy for a long time yet) as the year went on. At the moment, all is speculation but the question is 10 years nearer and a good deal less academic now than it appeared to be early in 1955.

Last year was not a good one for the coal industry judged on any criterion—financial results, output or manpower. Average weekly output in 1954 was 4·3 million tons. In the first eleven months of 1955 it was 4·2 million tons. The year ended, in fact, with 2 million tons less from the pits than in 1954, at 221·6 million tons. Coal supplies for industry and for domestic use were sustained by reducing exports and by raising imports. Between November, 1954, and November, 1955, numbers effectively employed went down from 640,000 to 634,000 and average output in tons per man-shift went up from 1·25 to only 1·26. This was in a year, too, when the industry spent about £96 million under the long-term investment programme compared with £85 million in 1954.

MINING MACHINERY

For some years to come the level of investment in the coal industry will be sufficient to provide a vital market for mining machinery, but the nature of the demand for machinery in British mines is gradually changing. Mechanical cutting and conveying of coal is now a general practice and the simultaneous cutting and loading at the face is the main line of advance at the present time. The A.B. Meco-Moore cutter-loader continues to be the most widely used machine, but progress has been made with other types and some useful co-operative work between the N.C.B. and the machinery manufacturers has been done on standardisation in an effort to preserve the iniative of individual manufacturers while gaining the advantages of standardised parts when it comes to repairs and renewals. The National Coal Board has spent about £1½ million on trials and modifications of new equipment, and six types of power loaders have been proved satisfactory. While the Meco-Moore machine has developed the cyclic system of longwall power loading with a wide webb, much work has been done of late on machines taking off narrow webbs and working on a continuous basis. Examples of these developments are the Samson Stripper, the Gloster Getter and the Anderton Shearer-Loader. The long wall Trepanner has been cordially received both at home and abroad.

In 1955 only about 9·4 per cent. of deep-mined coal output was power loaded, representing about 22 million tons. It has been estimated, however, that this tonnage will increase to about 48 million in 1960. On the basis of known percentage of coal power loaded up to the end of 1955, and taking into account the estimated increase in power loading over the next few years, this country is almost exactly 20 years behind the United States. In 1956, for instance, the percentage of coal power loaded in this country is expected to be about 11·4. The percentage in 1936 in the United States was 11·1. Progress continues to be made with ancillary machinery for the coal industry, and one of the most interesting developments has been the growing use of P.V.C. for multi-ply belts. Good progress has been made with the introduction of plastic belting, but a complete changeover will take time and will involve the purchase of 19 million ft. of belting.

Some idea of the trend of development can be seen from the graphs shown in Fig. 1 on this page. Despite the continued high level of investment in the U.K. coal industry, the deliveries of coal mining machinery have in most cases fallen off slightly over the year. Exceptions to this trend are coal preparation plant, and winding and hauling equipment. It is noticeable that despite the good prospects for power loading equipment, actual progress in terms of deliveries is not outstanding.

EXPORTS OF MINING MACHINERY

Exports of mining machinery continue to be disappointing. Although the mining machinery industry in this country is under constant stimulus to develop equipment for the difficult seams and varied conditions which now have to be catered for in the United Kingdom, this

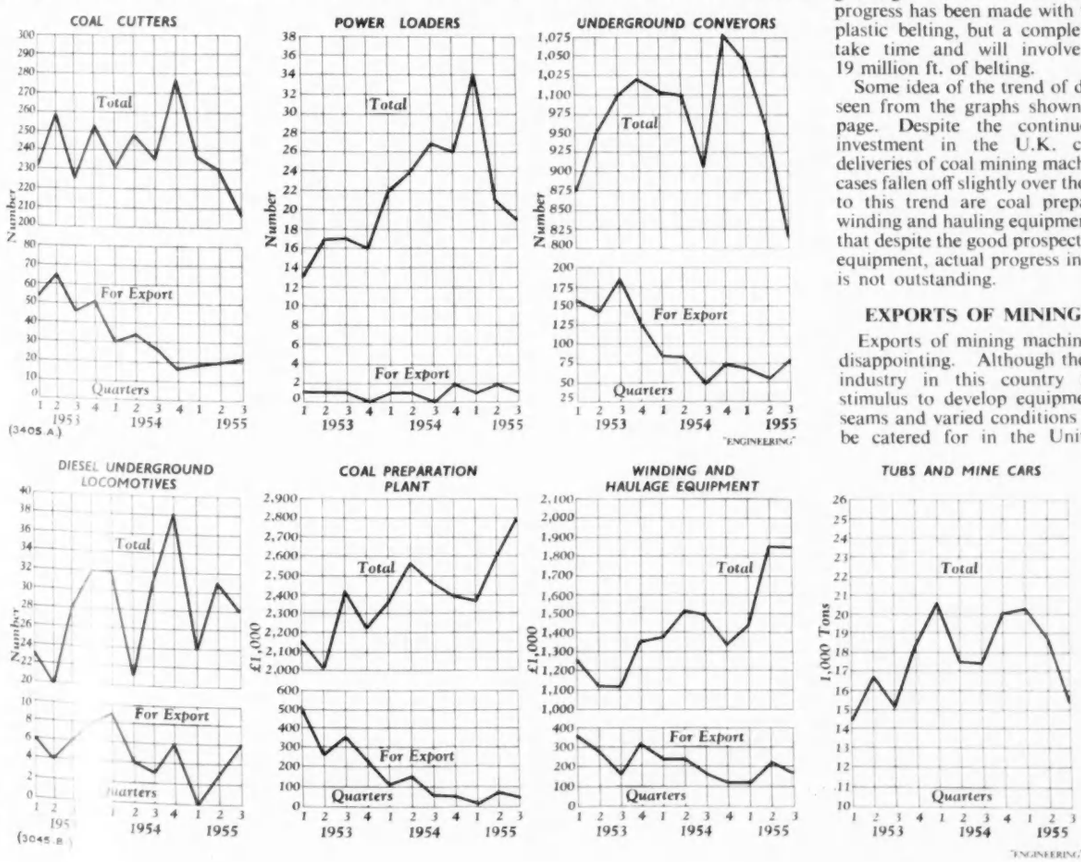


Fig. 1 Quarterly figures for U.K. deliveries of coal-mining machinery.

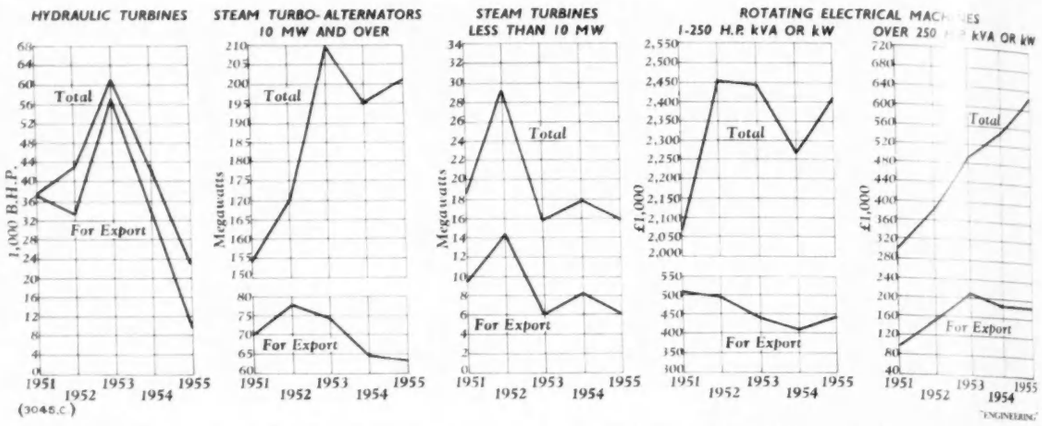


Fig. 2 Monthly averages from 1951 to 1955 (1955 based on total for nine months) for U.K. deliveries of electrical plant and machinery.

(3048.c)

stimulus carries with it the drawback that large-scale production is difficult to achieve. A basically difficult export problem is therefore made no easier when such customers as the South African mining industry reduce capital expenditure, as has been happening in recent years. The graphs at Fig. 1 show the general downward movement in the value of exports of coal-mining machinery. Opportunities to expand have been taken during the year and leading British manufacturers took part in the Paris Mining Machinery Exhibition held in July, 1955. A fillip was also given to the industry when the Burmese Government recently announced that it would sign a contract with Powell Duffryn Limited, for the exploitation of the Kalewa coalfield. This contract involves designing and installing colliery equipment. In October, 1955, a mission from the Canadian mining industry visited this country and stated that there was a market for many types of mining machinery in Canada if the business was actively sought.

The general prospect for mining machinery is a flow of steady (at times it might be agonisingly slow) orders from the U.K. mining industry, with special emphasis on power loaders, and better results in the export market if aggressive selling methods are used. In addition, there is bound to be a steady flow of orders from the U.K. industry for equipment required for the mining development programme. The search for new coal seams goes on, though it will be "costly and speculative." (This phrase was actually used by a spokesman of the N.C.B. when the Board's floating tower was towed into position last May off the coast of Fife, as part of the programme to prove coal reserves off the east coast of Scotland). This fact will not adversely affect the mining machinery industry as long as coal prices remain high.

It is quite clear that for several decades there is a critically important task to be undertaken in fuel efficiency. More will be said later about the impact of atomic energy on the Central Electricity Authority's programme, but the fact is now generally accepted that the conventional fuels will be required in ever increasing quantity for an indefinite period if, as is hoped, industrial production continues to expand at anywhere near its recent rate. The gap in coal supplies continues to widen. It is becoming increasingly likely that those pessimists were right who have said for some time that the coal industry would only raise its output above 200 million tons a year slowly and painfully despite all that might be done in the way of increased capital investment and improved management.

FUEL EFFICIENCY EQUIPMENT

With the gap in the potential demand and supply of coal becoming worse while the price of coal continues to increase, the task of the fuel efficiency expert becomes more urgent. The National Industrial Fuel Efficiency Service has made a useful start. It was estimated that by the summer of 1955, over £1 million had been lent under the Government scheme for industrial fuel-saving equipment and that approval had been given for loans for schemes expected to save 90,000 tons of coal a year. This figure happens to be exactly one hundredth of the original target set for eventual achievement and indicates how much still has to be done. It is abundantly clear, however, that there are two critical issues in fuel efficiency. First, there is a lack of sense of urgency on the part of many industrialists who continue to use out-of-date capital equipment which has been written off financially although its operating costs and rate of wastage are high. Second, there is a serious shortage of technical manpower to instal and operate more efficient equipment.

So far as the Central Electricity Authority is concerned the thermal efficiency of generation continues to improve. At the Authority's steam power stations as a whole it was 23·85 per cent. in the financial year 1954-55 compared with 23·40 in 1953-54. There is, however, now a serious gap between the C.E.A.'s estimated future needs for coal and the N.C.B.'s estimates of its ability to supply them, which is expected to become worse in the 1960's. In this article last year it was pointed out that the electricity authorities were turning an increasingly favourable eye on the use of fuel oil; during 1955 the C.E.A. announced a plan for making greater use of oil to help close the coal gap. Contracts have been signed by C.E.A. with some of the big oil companies for fuel oil at a price which will enable electricity to be generated at a cost, so far as fuel is concerned, equivalent to that achieved if coal were used. The Central Electricity Authority may be using oil to the equivalent of about 9 million tons of coal a year by 1960. An estimate from the oil industry has gone so far as to say that the potential demand for coal by 1964 is about 295 million tons compared with a possible supply of about 240 million tons. This would leave a gap of 55 million tons to be closed (it will be recalled that not long ago the rule-of-thumb estimate was a gap of 20 million tons by 1960!). It is therefore clear that the gap can be closed only by a very much increased use of fuel oil and by a continued drive towards higher fuel efficiency. As time goes on and the atomic age draws nearer, the prospects of those companies making equipment for improved fuel consumption grow brighter provided industry will spend the money and can find the manpower to instal and use more fuel-saving equipment.

C.E.A. EXPANSION

Progress in the expansion of generating capacity by the Central Electricity Authority has been noticeable in all fields over the last year. Much less was heard of a steel shortage than in 1954 (though this could recur in 1956) and the industry installed 1,530 MW additional "output capacity" during the financial year 1954-55. The official published expansion programme between now and 1960 provides for 10,000 MW of new plant, which means an average of about 1,700 MW a year. Since the estimated additional "output capacity" for 1960 is just over 2,000 MW, and the provisional figure for 1961 and 1962 is 1,950 MW for each, it is evident that the rate of expansion is scheduled to increase between now and 1962. There is

TABLE I. United Kingdom Exports of Mining and Well-Drilling Machinery other than Portable Power Tools.

	Quantity (1,000 cwt.)			Value (£1,000)		
	1953	1954	1955*	1953	1954	1955*
Power-operated coal cutters	25	24	19	804	795	718
Power-operated winders	67	36	39	883	527	572
Underground conveyors	103	65	47	983	626	492
Others	227	204	164	4,889	4,469	4,189
Total	422	329	269	7,559	6,417	5,971

* The 1955 figures in the tables are for the full year. Those in the graphs are estimates on 9 months.

TABLE II. United Kingdom Exports of Mining and Well-Drilling Machinery other than Portable Power Tools, by Countries of Destination

	Quantity (1,000 cwt.)			(Value (£1,000))		
	1953	1954	1955	1953	1954	1955
Union of South Africa	62	29	29	988	488	459
Rhodesia and Nyasaland	24†	27	18	328†	367	332
India	28	28	21	529	481	414
Singapore	1	1	n.i.	10	16	n.i.
Federation of Malaya	8	14	4	73	127	40
Australia	64	45	30	740	689	456
Trinidad	11	16	11	226	258	312
Other Commonwealth countries and Irish Republic	78	81	65	1,340	1,495	1,360
Netherlands	13	6	6	247	145	154
Venezuela	26	17	17	799	595	700
Other foreign countries	107	71	69	2,279	1,812	1,744
Total	422	335	269	7,559	6,473	5,971

† Figure for Northern Rhodesia. n.i. Not indicated.

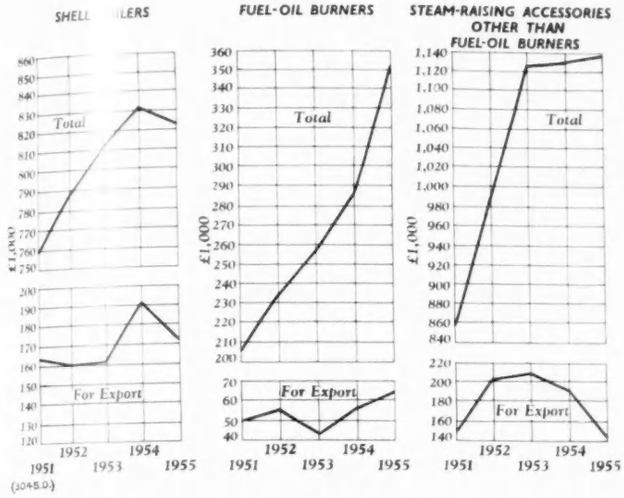


Fig. 3 U.K. deliveries of steam-raising plant (monthly averages, 1955 figures based on totals for nine months).

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every prospect, therefore, of a continued steady increase in the deliveries of heavy electrical plant in the next few years.

According to the Government White Paper on the provisional ten-year programme for the introduction of nuclear power to the electricity supply system, 12 nuclear power stations will be built and brought into commission by 1965, providing a generating capacity of some 1,500 to 2,000 MW. The construction of the first two stations is to start in 1957 and they will begin to operate in 1960 or 1961. To quote the British Electricity Authority's annual report for 1954-55, "If all goes well it may be practicable by the early 1970's to expand the rate of construction of nuclear stations to match the total requirements of new generating capacity." The capacity harnessed to nuclear power will therefore take its place in the published expansion programme of the Authority from 1957 onwards, and since the use of nuclear fission retains conventional generating plant, this development will have no effect on the demand for heavy electrical plant. The conventional boiler will, of course, be replaced by a form of heat exchanger and the companies which are dependent to an important degree on the demand for boilers from the electricity generating industry have already adjusted themselves to the change.

LOW-GRADE COAL

Further progress has been made with the building of large units to consume low-grade coals. The plant programme for 1960 comprises one unit of 100 MW, seven of 120 MW, two of 200 MW and 14 "standard" size units of 60 MW. Progress has also been made in the development of the first design of the 200 MW set which is scheduled for the 1959 programme. The boiler in this case is of twin-furnace design with assisted circulation, but otherwise it is a normal development from reheat practice used in the 120 MW set. Further full-scale trials of burning coal of various chlorine, sulphur and ash content, as well as of methods of alleviating boiler fouling and corrosion, have continued. This work must continue to be of the highest importance, for the success of the super-grid (of which a further 165 miles of double-circuit line were installed in the Authority's year 1954-55) depends on its being able to draw supplies of electricity from power stations built on those coalfields where the grade of coal is mainly lower, but from which an increasing proportion of future coal supplies will come.

A new thermodynamic cycle from which a high thermal efficiency is claimed has been under investigation for some time. Steam is the working medium and one of the outstanding features is a superheater designed to permit direct heat transfer from the burning fuel to the steam, thus eliminating the water boiling process. An experimental superheater test rig is now being tried out on a 15 MW machine to work as a pilot plant. Altogether the boiler-makers are undergoing a period of rapid technical change in the domestic market but there is no reason why their prospects should be adversely affected by the need on the one hand to increase the thermal efficiency of boilers using lower grade coals in conventional power stations or, on the other, the gradual substitution of nuclear for conventional power stations which is likely to gather impetus in the 1970's. Their problem is basically a soluble one, namely, how to adjust themselves to technical change in serving an expanding industry.

In the graphs shown in Fig. 2 some categories of electric plant deliveries are lower in 1955 than in 1954. This is partly due to the unevenness of delivery dates. Heavy electrical equipment, like a ship, takes a long time to build. As this article goes to press only the deliveries for nine months of 1955 are available and it is on these that figures for the whole year have been based. To that extent the graphs give only a provisional picture. The competitive power of the British heavy electrical engineering industry abroad is well known. Its bids in the U.S. market alone have won it international notice. In the long run, the outlook for the heavy electrical industry abroad is good if prices are competitive. The under-developed areas of the world are now in a position to accelerate their industrial development, for those which have no international currency can at least force the West to bid against the East. Such countries must build themselves up on clean water, better communications and cheap power. For the last of these, they need electrical generating equipment.

BOILER-MAKING

Prospects in the boiler-making industry are complicated. Reference has already been made to the impact of atomic energy on electricity generation in so far as it affects boiler-makers. Broadly, turnover from the basic industries is assured. Exports are largely a question of salesmanship and price, and recent performance is no more than fair. The demand for boilers by industry at large in this country is, however, more complex. The number of boilers which should be replaced on technical grounds in this country is very high, but accountants rather than engineers are apt to have the last say on replacement, especially when a credit squeeze is on and old equipment can be kept going for just one more year, so postponing the expenditure of capital. It is therefore possible that in the immediate future the credit squeeze may seriously affect the ordering of new boilers by industry for a limited period.

Such a development would concentrate even further the prospects of the boiler-makers on the Central Electricity Authority's requirements, which already account for 70 to 80 per cent. of the industry's boiler output for the home market. This may favour the large companies with big financial resources and, if this should be so, it means an intensification of a trend already apparent, namely, a tendency for boilers to become more expensive per unit of weight of steam produced as they become more efficient and hence cheaper to operate. Already, those companies which can prepare furthest ahead for the adaptation of boiler technology to future needs are those which can plough back large sums into reserve. Apart altogether from atomic power station requirements, the demand for Lancashire and vertical boilers is good, for the demand for process steam and space heating must surely increase as industrial output and factory space go on expanding.

In an age of industrial expansion, such as this, the future of the boiler industry must be sound. But there can be short-term setbacks and the big prizes will probably go to the big battalions.

Further articles in this Engineering Outlook series will consider the prospects of other branches of the industry, including agricultural machinery, machine tools, locomotives and rolling stock, aircraft, light electrical and cable, shipbuilding, textile machinery, motor vehicles, and general and constructional.

TABLE III. United Kingdom Exports of Electrical Machinery

	Quantity (1,000 cwt.)			Value (£1,000)		
	1953	1954	1955	1953	1954	1955
Generators complete:						
Driven by Diesel engines not exceeding 200 kW	143	150	181	3,879	3,923	4,347
Exceeding 200 kW	72	154	199	1,778	4,140	4,901
Other generators	81	73	82	2,662	2,556	2,315
Generators without prime movers and parts	293	232	264	8,403	7,180	7,965
Total	589	609	726	16,722	17,799	19,528
Converting machinery	14	9	16	442	332	560
Transformers	674	559	529	12,520	10,654	11,096
Rectifiers for power-house use	20	14	20	798	634	843
Switchgear and switchboards	455	419	439	16,145	15,222	15,374
Steam turbines	151	210	208	5,577	7,073	7,839
Total	1,314	1,211	1,212	35,482	33,915	35,712

TABLE IV. United Kingdom Exports of Boilers and Boiler-House Plant

	Quantity (1,000 cwt.)			Value (£1,000		
	1953	1954	1955	1953	1954	1955
Water-tube boilers	617	570	540	6,951	6,606	7,438
Vertical boilers	32	33	40	391	386	458
Other boilers	184	185	172	1,621	1,853	1,682
Economisers, feed-water heaters, and steam super-heaters	137	98	116	1,207	1,022	1,250
Other boiler-house plant	454	458	393	6,062	6,780	6,153
Total	1,424	1,344	1,261	16,232	16,647	16,981

EFFECT OF LEAKAGE PAST A PISTON*

EXPERIMENTS WITH A MOTORED TWO-STROKE ENGINE

By D. L. Brook†

This article describes the work carried out by the author on the mass variation due to leakage in a motored two-stroke engine. The first part explains an experimental method of obtaining a mass-volume diagram, the theoretical approach then being considered.

If a two-stroke engine is motored, the pressure-volume relationship is very nearly $PV^{\gamma} = \text{constant}$. If, however, leakage occurs, this law no longer holds, and an indicator diagram of the type shown in Fig. 1 is obtained. The actual shape of the diagram depends upon the size of the leak and the speed of revolution. A mass-volume diagram is rather difficult to obtain, but consideration of the indicator diagram shows it to be similar to Fig. 2. While the pressure in the cylinder is greater than atmospheric, leakage out of the cylinder occurs and from points *a* and *b* the mass decreases (Fig. 1). *b* is a minimum point as it corresponds to atmospheric pressure and from *b* to *c* the air mass increases due to leakage into the cylinder.

It can be seen that there is a net loss in air mass during any one cycle, and that port opening is accompanied by an inrush of air into the cylinder. Measurement of this air gives the total leakage for one cycle, and thus the point *c'* on the diagram (Fig. 2). To obtain a complete mass-volume diagram a similar technique is used for any point *d* in the cycle. Suppose that leakage from the cylinder is only allowed to occur from the point *a'* to the point *d*. The indicator diagram is now totally different from Fig. 1 and the mass-volume diagram is chopped off at the point *d*, thus following the arrows. The air measurement at port opening now gives the total leakage mass for the modified cycle which is the same as the leakage mass from the point *a'* up to the point *d* in the original cycle. Thus the point *d* is defined, and the locus of *d*, obtained by varying the instant at which the leakage is stopped, is the required diagram. It can be seen, therefore, that to obtain the mass-volume diagram for the motored cycle with leakage, an apparatus has to be designed which will cut off the leakage at any required instant during each cycle.

* "The Effect of Leakage on Compression and Expansion in a Non-Flow Process." Paper read before Section G of the British Association at Bristol on Tuesday, September 6, 1955.

† Department of Mechanical Engineering, University of Durham.

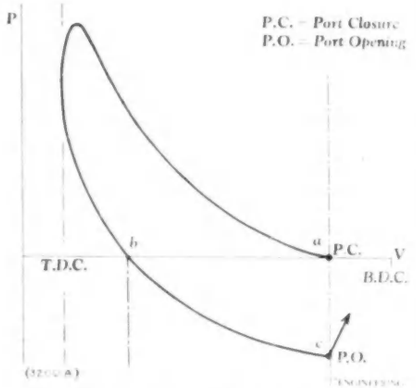


Fig. 1 Indicator diagram for a motored engine, showing the effect of leakage.

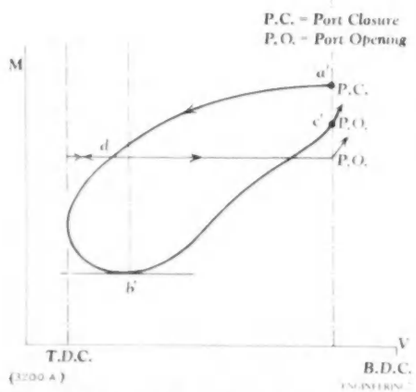


Fig. 2 Mass-volume diagram corresponding to Fig. 1.

EXPERIMENTAL APPARATUS

This can be done in either of two ways: by means of a large number of suitably shaped cams operating a valve covering the leakage area, or by using an electromagnetic device actuated by the crankshaft position to operate the valve. The apparatus necessary for the second method, which is the one used, is shown in Figs. 3 to 6. Fig. 3 shows the valve that controls the duration of leakage. This valve is clamped over a hole bored through the cylinder head and one of a number of orifice plates B is fastened inside the valve to give a known leakage area. The valve lift is $\frac{1}{4}$ in. and the spring G is designed so that when the valve is closed the stem A is under a tensile pull of 50 lb. The valve is opened by the electromagnet and rocker arrangement shown in Fig. 4. This is inverted and fastened over the valve cap so that when a current flows through the coil, the disc welded to the rocker is attracted to the coil and the valve is opened. The rocker stop J is arranged so that the air gap of the magnet is $\frac{1}{4}$ in. which is also the movment of the bearing point.

Fig. 5 shows the arrangement used for actuating the solenoid. It consists of a mild-steel disc, C, that rotates with the crankshaft but is insulated from it by a Tufnol disc, D. Thirty-six contacts, one of which is shown at E, are fastened to the edge of C by countersunk screws. For clarity only one of these contacts is shown on the diagram. The contacts are made either of brass or Tufnol, which is an insulator. At F one brush runs on the face of the contacts and another runs on the back of the disc, C. Leads from the two brushes are connected to the solenoid through variable resistors.

If, say, starting from B.D.C. there are 16 conducting contacts and then 20 insulating contacts, a current will flow for 160 deg. of crankshaft revolution from B.D.C. This means that the valve will be open for approximately 160 deg. from B.D.C. and closed for the remaining 200 deg. This system has an inherent time lag, and the apparatus shown in Fig. 6 is designed to obtain accurate values of the instants of valve opening and closure. It consists essentially of a drum, C, which is keyed to the crankshaft and carries carbon-backed paper. The point of

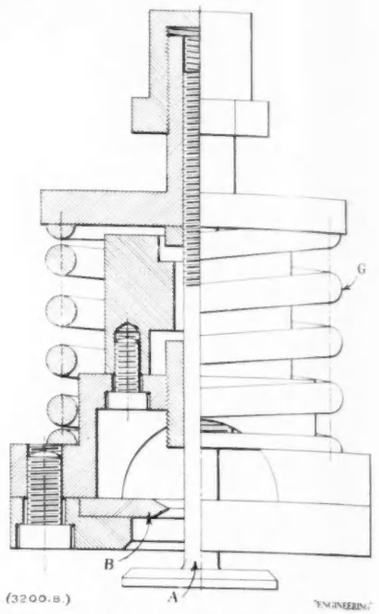


Fig. 3 Half section and elevation of valve designed to control the duration of leakage.

an indicator pen, D, is held a small distance from the drum and is wired to a high-tension coil and micro-switch. The micro-switch is fastened to the valve in such a way that just as the valve starts to open and just as the valve is about to close a spark passes across to the drum, C, from the pen, D. Two holes are thus punctured in the carbon-backed paper for every revolution of the crankshaft. Direct measurement from these holes gives the crank angles of both valve opening and closure. Experiments with this apparatus gave related diagrams of the type shown in Figs. 7 and 8. The indicator diagrams were obtained with a Farnboro' engine indicator equipped with the special low-pressure attachment described in B.S.R.A. report No. 97(3) (§ 1).

THEORETICAL CONSIDERATIONS

A theoretical check can be made on these sets of results if four equations that govern the condition of the air are known. Four equations are required as there are four unknowns: pressure, temperature, volume and mass. Three of the required equations can be immediately written down and are:—

the characteristic gas equation:

$$PV = MRT. \quad . \quad . \quad (1)$$

the variation of cylinder volume with time:

$$V = V_0 + \frac{V_s}{2}\left[1 + \cos \omega t + \frac{r}{2l}\sin^2 \omega t\right] \quad (2)$$

where V = cylinder volume at any time, t = time of revolution from B.D.C., ω = angular velocity, V_0 = clearance volume, V_s = swept volume, and $\frac{r}{l}$ = the ratio of crank radius to connecting rod length; and the continuity equation for flow

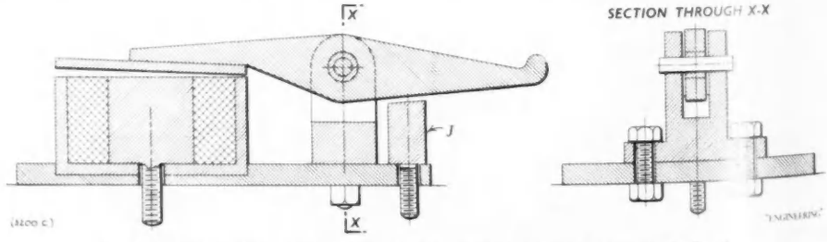


Fig. 4 Solenoid and rocker assembly for operating the leakage control va

through an orifice:

$$\frac{dM}{dt} = 2{\cdot}047\, a\, C_d\, P_1 \sqrt{\frac{1}{T_1}\left[\left(\frac{P_2}{P_1}\right)^{\frac{2}{\gamma}} - \left(\frac{P_2}{P_1}\right)^{\frac{1+\gamma}{\gamma}}\right]} \quad . \quad . \quad . \quad 3\,(a)$$

where $\frac{dM}{dt}$ the rate of mass flow, a = area of the orifice, C_d = coefficient of discharge, P_1 = inlet pressure, P_2 = outlet pressure, and T_1 = inlet temperature.

This last equation only holds good if the velocity of the air flow through the orifice is less than that of sound. If the pressure drop across the orifice is greater than that causing sonic velocity, equation 3(*a*) is replaced by

$$\frac{dM}{dt} = 2{\cdot}047\, a\, C_d\, P_1 \sqrt{\frac{1}{T_1}\left[(K)^{\frac{2}{\gamma}} - (K)^{\frac{1+\gamma}{\gamma}}\right]} \quad . \quad . \quad . \quad 3\,(b)$$

where K is the critical pressure ratio and equals 0·527 for air.

The fourth equation can be obtained by considering the state of the air in the cylinder over a small increment of time: (i) when the cylinder pressure is greater than atmospheric and (ii) when the cylinder pressure is less than atmospheric.

(i) The process of compression can be divided into a number of small steps, each step consisting of (*a*) a rise in pressure due to compression, and (*b*) a loss of mass, resulting in a drop in the pressure increase caused by (*a*). One of these steps is shown in diagrammatic form in Fig. 9.

Compression from A to B gives:

$$T'' = T'\left[\frac{P''}{P'}\right]^{\frac{\gamma-1}{\gamma}}$$

assuming the change to be adiabatic.

Leakage from B to C, considering the air left in the cylinder at C, gives:

$$T''' = T''\left[\frac{P'''}{P''}\right]^{\frac{\gamma-1}{\gamma}}.$$

Thus $$T''' = T'\left[\frac{P'''}{P'}\right]^{\frac{\gamma-1}{\gamma}}.$$

T''' now becomes T' for the next small compression, therefore

$$T = T_1\left[\frac{P}{P_1}\right]^{\frac{\gamma-1}{\gamma}}$$

where T is the air temperature corresponding to pressure P, assuming that compression started from atmospheric conditions. (Note that this does not mean that PV^{γ} is a constant as there has been a mass change.)

(ii) When the cylinder pressure is less than atmospheric the diagrams are as in Fig. 10. They consist of an expansion from A to B without leakage, and an increase in mass from B to C.

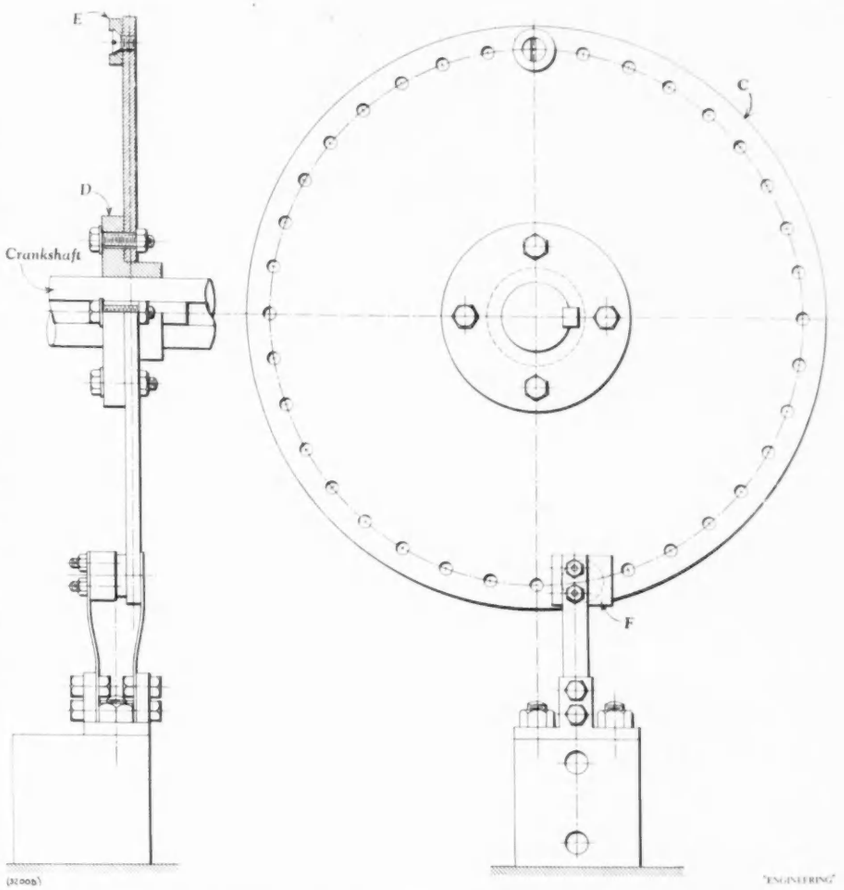


Fig. 5 Valve-timing mechanism: contacts on the disc energise the operating solenoid.

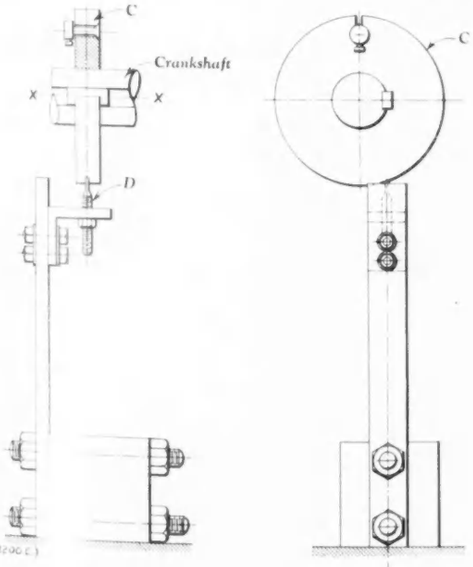


Fig. 6 Valve-timing indicator. A spark from the pen marks the actual points of opening and closing.

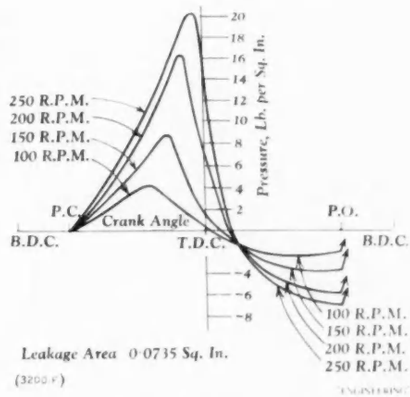


Fig. 7 Indicator diagrams for different speeds.

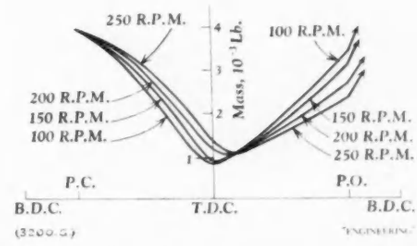


Fig. 8 Mass-volume diagrams corresponding to Fig. 7.

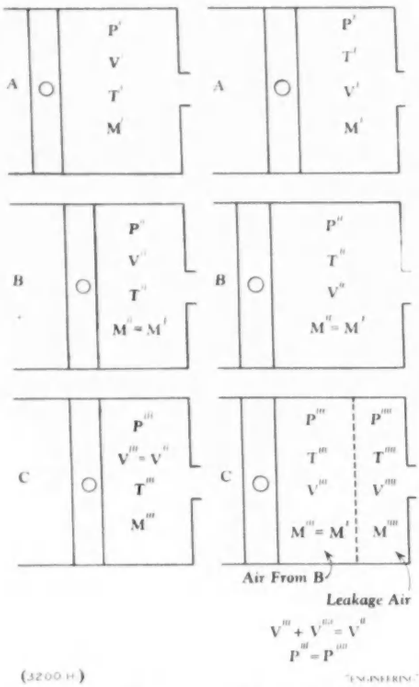


Fig. 9 Small stage of compression process $P > P_A$

Fig. 10 Small stage of expansion process $P < P_A$

For A to B

$$T'' = T' \left[\frac{P''}{P'}\right]^{\frac{\gamma-1}{\gamma}}$$

with the usual assumption. For B to C, considering the air in the cylinder at B:—

$$T''' = T'' \left[\frac{P'''}{P''}\right]^{\frac{\gamma-1}{\gamma}} \quad \therefore T''' = T' \left[\frac{P'''}{P'}\right]^{\frac{\gamma-1}{\gamma}}.$$

Now, the incoming air is at temperature T'''' that is governed by the law for adiabatic-expansion through an orifice. That is

$$T'''' = T_A \left[\frac{P''''}{P_A}\right]^{\frac{\gamma-1}{\gamma}} = T_A \left[\frac{P'''}{P_A}\right]^{\frac{\gamma-1}{\gamma}}.$$

For the first step in the expansion, $T' = T_A$ and $P' = P_A$ as these are the conditions at the end of exhaust and at the beginning of suction.

$\therefore$ For the first step $T''' = T_A \left[\frac{P'''}{P_A}\right]^{\frac{\gamma-1}{\gamma}} = T''''$.

That is the temperature of the air entering the cylinder is the same as that already there; and after the first slight change in pressure,

$$T''' = T'''' = T, \text{ say, } = T_A \left[\frac{P}{P_A}\right]^{\frac{\gamma-1}{\gamma}}$$

where P has been written for P'''.

This temperature T becomes T' for the second step in the expansion, and T''' for the second step is

$$T''' = T' \left[\frac{P'''}{P'}\right]^{\frac{\gamma-1}{\gamma}} = T_A \left[\frac{P'''}{P_A}\right]^{\frac{\gamma-1}{\gamma}} = T''''.$$

Thus, once more the temperature of the air entering the cylinder is the same as that already there, and continuing the process gives

$$T = T_A \left[\frac{P}{P_A}\right]^{\frac{\gamma-1}{\gamma}}.$$

Thus, for both suction and exhaust,

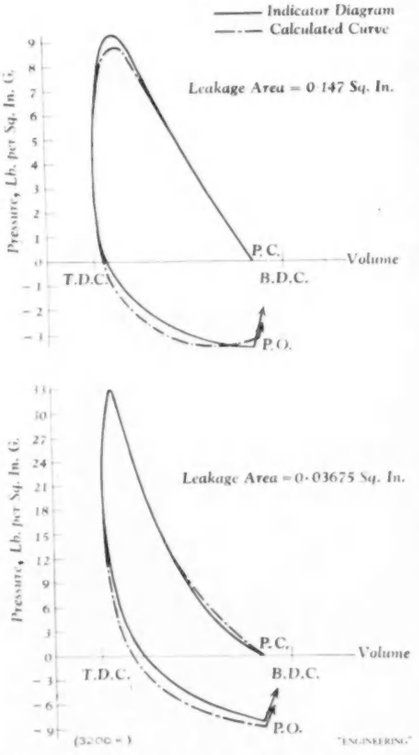
$$T = T_A \left[\frac{P}{P_A}\right]^{\frac{\gamma-1}{\gamma}} \quad . \quad . \quad . \quad (4)$$

Using equations (1), (2), (3) and (4) mass-volume and pressure-volume diagrams can be calculated for any known leakage area and speed of revolution.

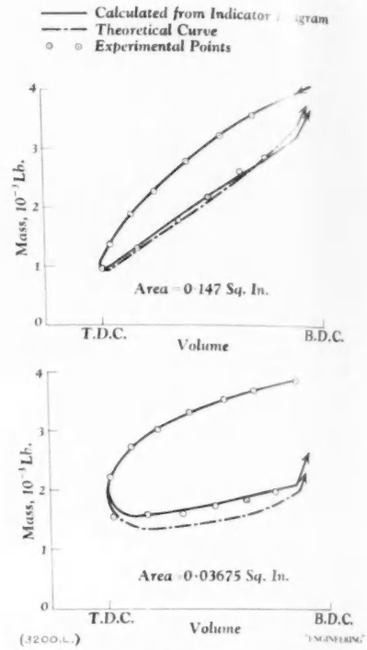
Due to the number of different stages in any one cycle and to the difficulty in integration, one simple equation governing the mass-volume relationship cannot be obtained. The method of calculation is therefore a step by step one starting from the conditions of port closure at the beginning of compression and working round the cycle to the point of port opening by the piston. The results of calculations of this kind are shown in Figs. 11 to 14, which compare theoretical and experimental results. Figs. 13 and 14 also include curves calculated directly from the relevant indicator diagrams by means of equation (4). This last method of calculation is very useful as the results can be obtained without complicated apparatus, knowledge of the leakage area, etc.

It can be seen from these curves that the experimental results check very well with those theoretically predicted. The first two, Figs. 11 and 12, are those of the pressure-volume relationship inside the cylinder at 250 r.p.m. for both the largest and the smallest of the orifices used. Although the pressure range of these curves is rather different, their characteristics are very similar. Starting from port closure, just after B.D.C., the pressure rises until just before T.D.C., falls off as the rate of volume change becomes small and then drops to below atmospheric during the expansion stroke.

In each case the calculated curve is very close to the indicator diagram for the compression stroke. Unfortunately, differences do occur in the expansion stroke and the calculated pressures are below those obtained from the indicator. One possible explanation for this lies in the derivation of equation (4) for the suction part of the process. The kinetic energy of the air flowing through the orifice into the cylinder has been neglected. When this air is brought to rest its energy is released in the form of heat



Figs. 11 and 12 Pressure-volume diagrams for two leakage areas. Motor speed 250 r.p.m.



Figs. 13 and 14 Mass-volume diagrams corresponding to Figs. 11 and 12.

which will cause a rise in both the temperature and the pressure inside the cylinder, and may account for the difference in the calculated and experimental results.

This effect could possibly be allowed for by replacing equation (4) by

$$T = T_A \left[\frac{P}{P_A}\right]^{\frac{n-1}{n}}$$

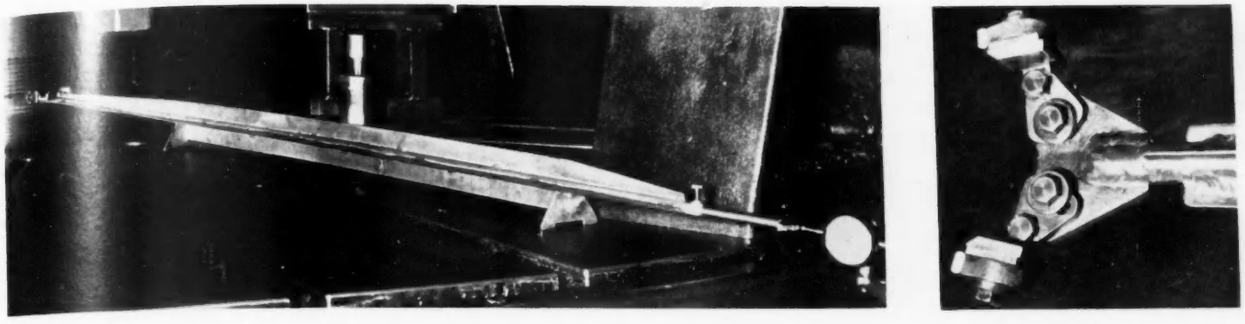
for the suction part of the process, and by choosing a value of n somewhat less than γ. The actual value of n would have to be theoretically estimated—a rather difficult task.

The mass-volume curves once more show the effect of the pressure difference between the calculated and experimental results. It is interesting to note that the experimental points lie closer to the curve calculated from the indicator diagram than they do to the totally theoretical curve and that, on the whole, they lie below the former for the suction part of the process. By choosing a value of n less than γ the temperature for this part of the process is increased and hence the mass is reduced. The indicated line is thus brought down to the experimental points, a fact which assists the argument just given as the reason for the discrepancies between the theoretical and experimental results.

CONCLUSIONS

(I) The application of the continuity equation for flow through an orifice under fluctuating pressure conditions seems to hold good when the pressure variation is not very great and the frequency of the oscillation is small, e.g., five cycles per second maximum. (II) The theoretical approach seems to be well justified for the exhaust part of the process, although some modification is needed if accurate results are to be predicted for the suction part. (III) The experimental method used to find a mass-volume diagram is very satisfactory, as is also the method of applying equation (4) to a low-pressure indicator diagram.

Acknowledgment.—This work was undertaken as a project in the Honours Course in Mechanical Engineering at King's College, Newcastle-upon-Tyne (University of Durham) under the supervision of Professor Aubrey Burstall to whom the author expresses thanks.



(a) (b)

Fig. 1 Device for setting to lower wheel journal on gear hobbing machine. In hobbing there are still operators who set up to the periphery of the blank rather than to the journal. The latter is basically more correct and the instrument shown in (a) is designed to perform the measurement for, say, eight consecutive positions of the lower journal of a wheel; (b) is a close-up view of its inner end, showing magnets with keeps in position.

REDUCTION GEARING FOR SHIPS

DESIGN CRITERIA AND PRINCIPLES OF MANUFACTURE

The standards of design and manufacture necessary to produce reduction gearing of sufficient accuracy for marine requirements were the subject of the twenty-eighth Thomas Lowe Gray Lecture delivered before the Institution of Mechanical Engineers on January 20, 1956, by Mr. A. W. Davis, B.Sc., M.I.Mech.E. Entitled "Marine Reduction Gearing," the lecture not only listed certain essentials of design, but also made reference to some important practical features of production which the speaker believed were still receiving inadequate attention. Some observations were also made on gear-case alignment and maldistribution of loading due to pinion distortion, and on the establishment of cardinal relationships affecting tooth design and criteria of tooth loading. The speaker also suggested that with highly loaded gears small gear-face-width ratios gave unnecessary sensitivity to bearing misalignment. The lecture ended with some notes on the trend which developments seemed to be taking. Some points from the lecture are given in this ariticle.*

MACHINING AND FINISHING

B.S. 1498 : 1954 calls for a minimum cyclic worm to worm-wheel tooth error of 0·0003 in. Such a limit can to-day be readily achieved and if it is regular in its characteristic from tooth to tooth, can be reduced further by implanting an error of reverse character in the gear driving the work shaft, to give a total effective error of no more than 0·0001 in. If the master worm wheel has been split circumferentially and the parts displaced relatively to minimise cumulative pitch error, such regularity in the worm-error characteristic is upset, depending upon whether the upper or lower part of the wheel is in immediate mastery; in such circumstances further compensation of the "duo cyclic" error is impossible. The moral is that splitting does no more than transfer error from one source to another.

In the hobbing process it is understood that there are still gear-cutter operators who set up to the periphery of the blank rather than to the journals. The former arrangement leads to a better cumulative pitch measurement in the case of the wheel if, as is usual, the pitchometer bears on the periphery, but the latter is basically more correct. An instrument for achieving the measurement satisfactorily on, say, eight consecutive positions of the lower journal of a wheel is shown in Fig. 1, (*a*) and (*b*), the latter being a close-up of its inner end, which incorporates magnets; these just clear the journal (in the illustration, the keeps are shown still in place).

The custom is not yet universal to finish-cut both helices of an element with the head or table rotating in the same direction, so that even minor pitch variations are reproduced in phase in the two helices; this would obviate pinion shuttle however small and the relatively large variation in tooth loading necessary to produce it.

The setting of the job, not being an integral part of the machine, provides a source of error which must always be watched. If a gear is to be left unshaved it is even more imperative, if tooth profile is not to be ruined, that the eccentricity should not exceed [illegible] in. The positioning of the job on the spindle has been the subject of misunderstanding. The taper on a roughing hob is so located as to distribute the load over as many cutting edges as possible, but, regardless of the tooth not being to full depth, it never gives a correct involute contour. For this reason taper on a finishing job is not permissible.

SHAVING AND LAPPING

Vital improvements have been made quite recently in the production of high pitch accuracy in lead-screws, and a limiting error of 0·0002 in. in 30 inches may now be obtained. Even with such accuracy a degree of selectiveness is still likely to be required in any subsequent shaving; that is, the infeed of a single-sided cutter is varied in traversing the pinion face to give a proper adjustment of marking in the meshing frame.

It is this consideration, and also the difficulty of hobbing a correct tooth profile, that necessitates a post-hobbing process in the production of a first-class gear. By the same process, it is convenient to relieve bearing from the ends of the teeth, thus dispensing with handwork, and minor hobbing undulations are reduced to the extent shown in Fig. 2 which reproduces typical Tomlinson undulation records before and after shaving.

Where the jobbing machine calls for kinematic precision under temperature control the shaving process can, subject to avoidance of quick variation in temperature, be carried out in open shop but calls for the most minute attention to shaving-cutter design and manufacture, particularly as to profile finish. It must not be regarded as a method of correcting a badly hobbed gear, and in inexperienced or careless hands, there is no quicker way of mutilating a good gear than in a shaving machine.

INTERFEROGRAMS

For this reason it can be misleading to accept as universal evidence records of measurement or performance of particular shaved gears. Shaving has, because of particular incidents, been suspected of pre-stressing the tooth surface, and this could probably be brought about by a wrong technique. The surface finish produced by the shaving process has also been open to doubt and interferometric photographs have been published (ENGINEERING, vol. 179, page 274, 1955) demonstrating damage to tooth surface with inferences reflecting upon the whole process.

To restore a balance of outlook on this highly scientific approach, Fig. 3, (*a*) and (*b*), is included to show interferograms of a typical production gear before and after shaving, and lacking the implied characteristic. The overall magnification of the photographs is about forty times, and it will be seen that while surface errors in excess of the fringe separation value of 0·00013 in. are present after hobbing, the surface discrepancy after shaving is generally less than one-quarter of this amount. A practical verdict on the merits of the shaving process may be reached after studying the performance of selectively shaved gears during ten years of operation.

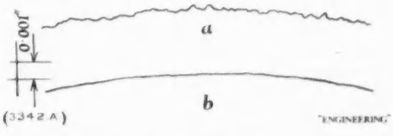
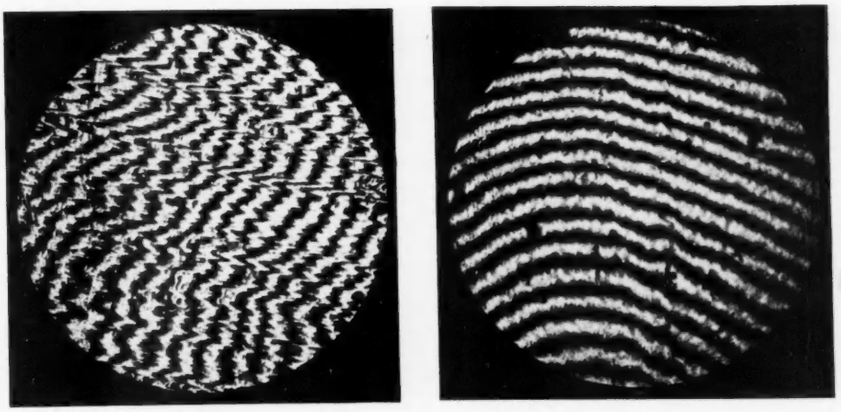


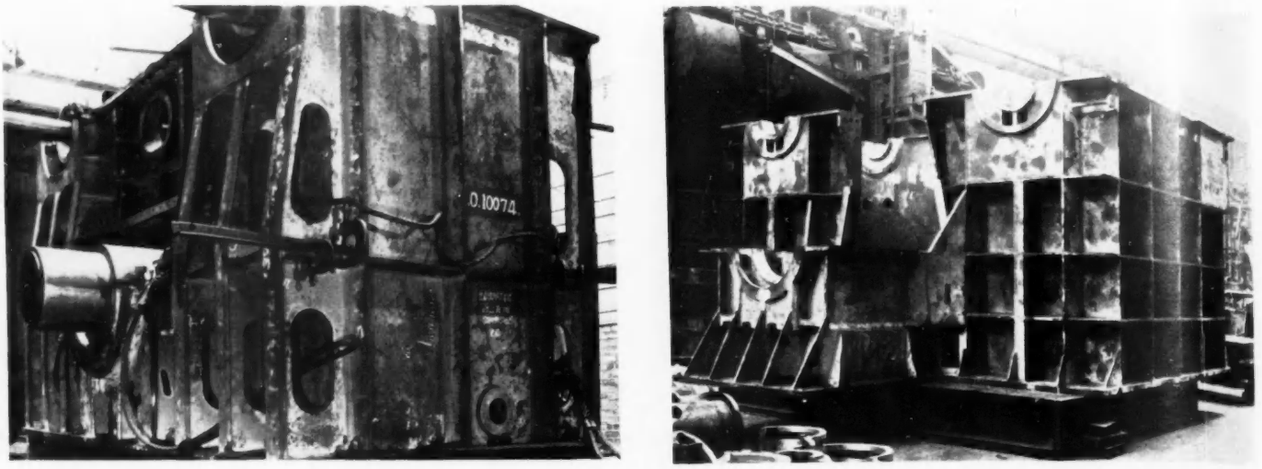
Fig. 2 Tomlinson undulation records: (a) before shaving and (b) after shaving. In producing a first-class gear, post-hobbing processes serve to eliminate handwork and reduce minor hobbing undulations.



(a) (b)

Fig. 3 Interferograms of a production gear tooth surface: (a) after hobbing, (b) after shaving; overall magnification about forty times. Although shaving has been suspected of pre-stressing the tooth surface and impairing surface finish, this has probably only occurred as a result of faulty shaving technique.

* Deputy managing director of the Fairfield Shipbuilding and Engineering Company, Limited, Glasgow.



(a) (b)

Fig. 4 Ribbed gear-case: (a) shallow side ribs, (b) deep side ribs. Gear-case walls must be sufficiently strong to resist the most serious distortion imposed by the torsional flexure of a hull about a fore and aft axis. To meet this requirement end walls are heavily ribbed, but, as can be seen, the side walls receive rather less attention.

Shaving may be replaced by lapping with abrasive under most carefully controlled conditions. This is a correcting process which is the more satisfactory the less there is to correct; it reflects a principle perhaps found at the peak of its usefulness in the functioning of an extreme pressure (E.P.) lubricant, reference to which will be made later.

STIFFNESS AND ALIGNMENT

The provision of adequate stiffness in a typical primary gear-case presents no difficulty, but a generous number of well-fitted bolts must locate the cover, which usually carries the pinion, to the main body of the gear-case.

The secondary gear-case is a different problem. The cover cannot be regarded as contributing to tiffness and the gear-case is in effect an open-topped box with quite a slender bottom, as represented by a flexible hull structure. The one form of distortion which the hull can prevent is the collapse of the horizontal rectangle of the base of the gear-case, but the walls of the gear-case must be capable of preventing any tendency to collapse at the top. The walls must likewise strongly resist the most serious distortion the hull will attempt to apply by its torsional flexure about a fore and aft axis.

This necessitates (i) heavy ribbing of end walls, (ii) heavy ribbing of side walls, (iii) horizontal breadth of corner ties between (i) and (ii), and (iv) massive construction, including numerous well-fitted bolts for removable panels to admit the main wheel. Attention is usually give to (i), with the design more or less dictated by the bearing housings, but (ii) often receives less detailed attention (compare Fig. 4 (*a*) and (*b*) which suggests that (iii) tends to be overlooked; (iv) is frequently neglected and it would sometimes seem that the designer's only concern has been the maintenance of oil tightness.

When these features receive adequate attention, the gear-case is sufficiently strong not only to maintain its shape, however it may be supported, but to resist, without unacceptable distortion, the twisting which the hull may apply in a seaway. The long-standing question follows: why then provide more than three local supports for the gear-case so that it might be freed of the consequences of hull distortion? Surely the answer lies for every example in an assessment of whether the seating can contribute more stiffness than distortion. If the seating is to be effective, it must continue in depth what is in effect the double-box section of the gear-case with heavy corner tying, all corresponding to (i), (ii) and (iii) above.

MESHING

The bearing of the teeth must be the final test of alignment on board, and no difficulty is experienced if the gears have been previously selectively shaved to suit the meshing in a precisely aligned frame of rigid proportions such as that shown in Fig. 5. Meshing tests must be made by an examination of the removal of thinly applied Talbot blue or similar hard-setting lacquer, and not of the transfer of paint from one tooth to another. Final readjustment on board should be unnecessary with a properly designed gear-case and a suitable system of chocking to reproduce gear-case alignment readings recorded in the shop.

Initial accuracy of gear-case alignment in the shop can best be achieved by accurate boring of the gear-case housings. Correction that must follow inaccurate boring is uneconomical of skilled labour and difficult to carry out when working towards a fixed-bore size guided by long stick micrometers and spirit levels on mandrels. These can never properly fit the changing size of housing, and the whole equipment tends to produce a scatter of measurements.

PRECISION BORING MACHINE

Precision boring carried out by the use of jigs is troublesome for limited numbers of any one size, and the use of a boring machine having special features for the purpose is advantageous. Fig. 6 shows such a machine (an Innocenti-CWB horizontal milling and boring machine, designed by Charles W. Berthiez and built by Innocenti of Milan as installed at the works of the Fairfield Shipbuilding & Engineering Co., Ltd.) in which a planer-type table carries the gear-case from bore to bore with a uniformity in horizontal alignment that would be unattainable by independent movement of boring and steady heads on a fixed-bed machine. Vertical alignment of boring and steady heads is determined by a mercury levelling device with high-pressure rubber tubing passing under magnetically-locked stabilising pulleys arranged in shafts in the concrete foundation. This again is more accurate than the use of a telescope, which is peculiarly sensitive to weaving errors of the headstock.

In the particular machine referred to, the table moves with a maximum roll and horizontal weave of 0·0004 and 0·0001 in. respectively at a radius of 80 in. over a travel of 120 in. The error in vertical movements of the saddle and of the steady bearing, measured parallel to the table movement over a travel of 60 in. is in each instance no greater than 0·0003 in. The machine is housed in a room which can be temperature controlled to prevent relative distortion between successive bores, and it is found that the average probable error in housing alignment on a gear-case to take, for example, a wheel of 12 ft. diameter is about 0·0010 in.

If necessary, to provide additional rigidity for the boring bar, an intermediate steady can be quickly positioned within the gear-case structure by telescope setting to the pre-aligned boring and steady heads. The housings are finished to size by micro-set tools of standard construction.

PINION DISTORTION: TOOTH FORM

It has been customary to design gears allowing for a maximum circumferential tooth separation of 0·00075 in. due to combined bending and torsion of the pinion on the assumption of a uniformly

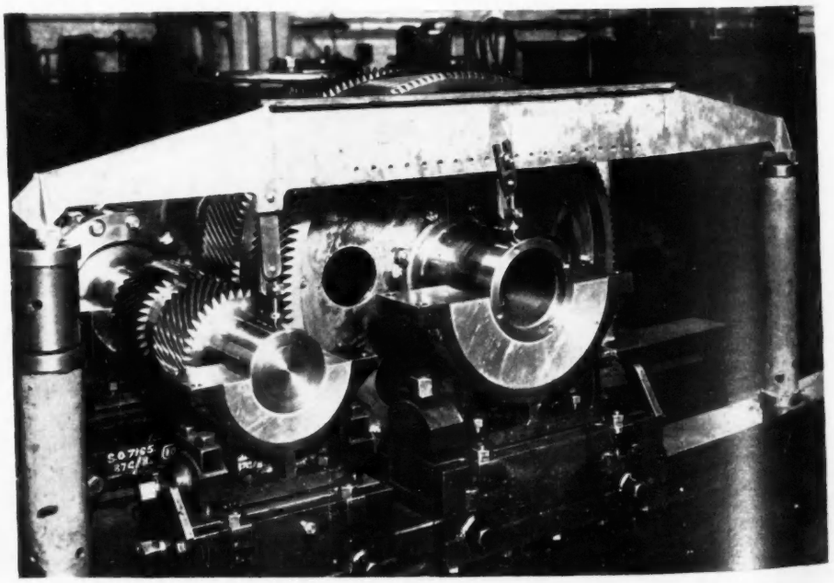


Fig. 5 Primary gear meshing frame. The bearing of gear teeth must be the final test of alignment on board, and this is likely to be satisfactory if the gears have been previously selectively shaved to mesh correctly in a precisely aligned rigid frame.

distributed load along the teeth. In fact the teeth deflect differentially along their length in sympathy with an altered distribution of load brought about by the distortion. Values of tooth flexibility factor (in terms of inches of tangential deflection in a circumferential plane per lb. of tangential load per axial inch of gear face) have been determined from repeated full-size deflection tests on the equipment illustrated in Fig. 7. A more detailed treatment of this problem was given in the Mr. Davis's lecture.

In its approach to gear design, B.S. 436 takes the reader immediately into an empirical treatment based on long experience in general operation, focusing on wear and fatigue life. But the marine gear must be provided with such a margin of safety to meet exceptional conditions of storm, that these factors have no primary application, and the best treatment for design is therefore by recourse to more fundamental principles rather than general conventional formulæ.

Reference was also made in the lecture to the three criterion coefficients relating respectively to tooth failure by pitting, root stress and scuffing, which together served as a convenient basis for the analysis of existing and proposed designs. Loading and materials were also considered as factors in design analysis, and the derivation of expressions for this purpose was dealt with at length both in the lecture and in appendices.

TIP AND END RELIEF

Tip relief on a spur gear is necessary to provide "sweetness" of engagement in compensating for the deflection of the load-carrying teeth. The comparable feature in a helical gear is the relief that must be provided at the ends of the pinion teeth; no such consideration arises affecting tooth profile. Secondly, because gears have sometimes been designed in a manner that has made them susceptible to scuffing, an erroneous impression has arisen that heavy tip relief is a basic necessity of normal engagement of helical gear teeth, in disregard of the palliative nature of the measure.

In extreme cases tip relief has been progressively increased to amputate tooth surface and when the measure has not been carried sufficiently far to overcome scuffing it has been described as inadequate with reference to the thickness reduction rather than the radial dimension of mutilation. With a gear tooth properly designed to meet the requirements of the transmission, the factors dictating the need for tip relief are entirely different.

The sole legitimate reason for profile correction is to provide for the generation of a hydrodynamic oil film at the regions of initial and final contact. This is effected by a tip relief of, say, 0·00025 in. plus an allowance to compensate for Hertzian depression which, unlike bending and shear deflection, tends to absorb tip relief effect. The total relief to be provided varies then from, say, 0·0003 in. for a 0·4 in. pitch to 0·0005 in. for a 0·8 in. pitch. The problem of producing these small corrections naturally requires patient attention. In shaving, the requirement is met by a swelling on the root of the cutter profile of about twice the desired relief.

Finishing by hobbing does not provide assurance that the correction will be properly achieved. Two fundamental difficulties arise. Firstly, there may be a slight eccentricity of running, producing errors, even under most careful control, greater than the required correction. Secondly, the generating process is such that the position of the swelling on the hob tooth to give proper tip relief varies with the diameter of the gear to be cut, and unless a much greater relief is to be accepted for large diameters, with loss of effective tooth surface, a considerable stock of only slightly differing hobs must be carried.

End relief to be greater than the total tooth deflection and depression should be, say, 0·0005 in. for a 0·4 in. pitch, to 0·0015 in. for a 0·8 in pitch, normal to the teeth on both flanks. The relief is solely to provide smoothness of entering engagement, and, with this ensured, root strength is adequately safeguarded by the conventional chamfer and the fact that the enhanced flexibility of the tooth end does not permit that part to carry more than a reduced load relative to the body of the tooth; the total deflection all the way along is naturally constant and productive of uniform stress. The provision of this slight relief which should wash away in about ¼ in., can form part of the selective shaving process. Excessive end relief is detrimental in just the same way as excessive tip relief.

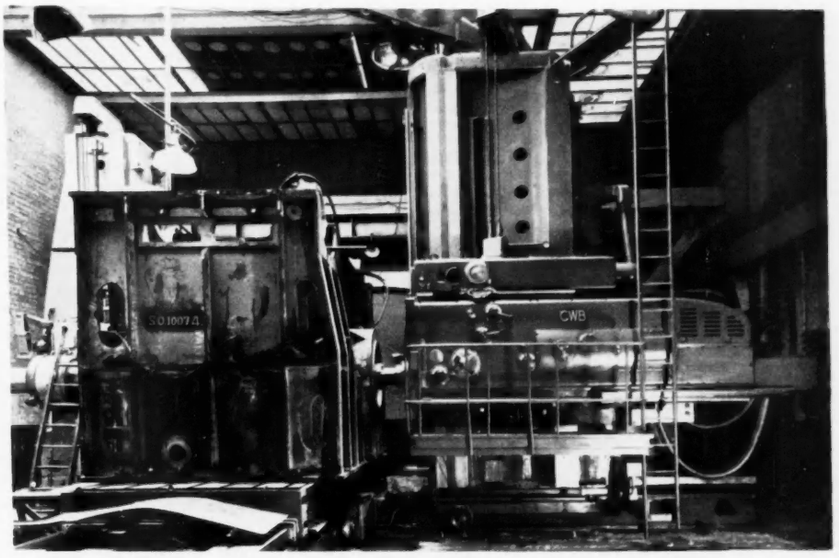


Fig. 6 Innocenti-C.W.B. horizontal boring and milling machine suitable for precision boring without the use of jigs. A planer-type table carries the gear-case from bore to bore with high accuracy in horizontal alignment.

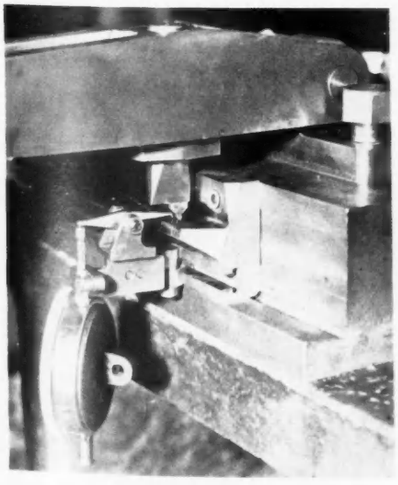


Fig. 7 Equipment for measuring tooth flexibility; the beam extending beyond the left-hand edge of the illustration is a loading arm from which appropriate weights are suspended.

COUPLING TEETH AND VIBRATION

Vibration measurements on flexible coupling teeth carried out with the aid of piezo-electric pick-ups associated with a cathode-ray oscillograph indicated on one vessel the build-up with power of a disturbance at coupling-tooth frequency brought about by the out-of-alignment of primary wheel and secondary pinion when taking up the load position in their respective oil clearances (resulting in localised contact on a diametral line across the coupling teeth).

A similar disturbance was not observable when a sister vessel was tested under similar conditions with couplings of identical construction, but with the alignment between the primary and secondary gears modified to give concentricity in the ahead running position, and it is recommended that primary wheels and secondary pinions be aligned in this way, and that double the alignment error can be accepted going astern. Such an arrangement is also to be preferred when no sliding coupling is fitted so as to minimise any off-setting bending moment on the gears in the ahead direction of rotation.

Sliding couplings when fitted to a quill shaft are, as their name implies, intended to allow a shuttling of the secondary pinion without any restriction from the inertia of the primary gears. But when heavy torque comes on a coupling it does not slide readily and damage to the axial locating faces of primary wheels has occurred owing to an excessively flexible main thrust seating, with the axial load through the gears providing an indefinite maldistribution of torque between the two helices of the secondary gears.

No fretting has been experienced with small toothed couplings having claw teeth thinned towards the ends and lubricated centrifugally through holes drilled to the roots of the teeth; the materials used were nickel-on-carbon steels. The latest development is to apply the Sulphinuz process to the claws after cutting the teeth, since the distortion under treatment is negligible, and it may be that this process will eliminate the need to use an alloy steel in one of the elements. This should have the effect of maintaining the units immune to fretting and reducing the coefficient of friction between the teeth, so making the coupling more ready to slide. Similar treatment is being applied to turbine couplings.

HIGH-SPEED BEARINGS

A great deal of valuable work has been carried out by Pametrada that will result in the establishment of a shorter length-to-diameter ratio on high-speed bearings. New methods of bush construction are advocated, and it is understood that some results of this valuable work are to be published shortly.

One trend which might not be altogether of advantage to the performance of gear teeth is the tendency to reduce diametral clearance. This has resulted from suspected vibration due to whirl of the bearing oil film under light loads (ENGINEERING, vol. 179, page 243, 1955), but it has been shown that the ability of a journal to correct maldistribution of loading by slew is in proportion to the bearing clearance.

A gear should be so designed as to make correction unnecessary and indeed it has been demonstrated that with a properly designed gear the slew correction is very small, but in the event of a disturbance to the bearings causing malalignment, the effect can be quite substantial in minimising load concentration. Reduction in pinion-bearing clearance should therefore only be carried out after the most careful consideration of all the circumstances of service.

MATERIALS FOR GEAR-WHEEL RIMS

Development in the production of highly finished teeth led naturally to the desire to adopt higher tooth loadings by taking advantage of higher tensile steels with greater surface hardness and root strength, since it was considered that loss of plasticity for the accommodation of tooth-contour irregularities would axiomatically be compensated by the higher finish.

In fact, this is an over simplification of the problem, and the relative merits of retaining certain qualities

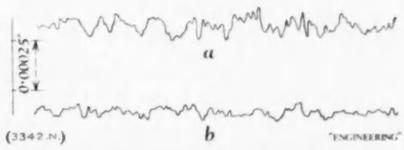


Fig. 8 Talysurf records of tooth pinion surface, (a) before and (b) after running with an E.P. (extreme pressure) lubricant. A so-called chemical polishing takes place.

of materials with the sacrifice of others will emerge only as the results of further research appear.

A method has been described (given in an appendix to the lecture) for segregating the different qualities of pairs of mating-gear steels so that the coefficients reflecting gear performance may properly represent these qualities in their appropriate setting and with a reasoned proportionality. Basically, a higher-duty material is required in order to obtain a greater fatigue resistance to pitting, and the material conditions which supply this quality also provide for a greater resistance to fatigue in relation to root stress. Toughness, that is the ability to deform without inter-crystalline cracking, is provided in greater measure by an alloy steel than by a high-carbon steel and this consideration has led to the demonstration of one viewpoint that higher duty can best be obtained by making both pinions and rims of alloy steel having suitable ultimate tensile strength, differing by, say, 15 tons per square inch to minimise mutual weldability. Unfortunately, such a difference in ultimate tensile strength between the mating elements is not effective in providing an increase in resistance to scuffing proportional to the increase in fatigue resistance.

SCUFFING AND E.P. LUBRICANTS

The reason for the scuffing of an alloy-steel combination may not be completely determinable, and the assessment of different combinations must be the subject of research. One factor that might aggravate the condition is that the difference between the two alloy steels is largely in their heat treatment which locally becomes purely historical when an area, however small, has reached welding temperature. On a subsequent contact there may be a local molecular affinity between wheel and pinion which is not foreshadowed by study of the respective ultimate tensile-strength values of the test-pieces.

More definitely it can be added that as an alloy steel has a relatively high yield point with poor work-hardening qualitities, the tooth asperities which are so small as to be of no consequence when a carbon gear is employed, do actually assume a significance that cannot be ignored. The difficulty can be satisfactorily overcome by employing one of the E.P. (extreme pressure) lubricants suitable for turbine machinery; the function of the additive material in these oils is to form a sulphide or an oxide locally on the tooth surface where the temperature is raised by metallic contact, thereby not only preventing molecular cohesion but corroding the local high spot and effecting a so-called chemical polishing. Fig. 8 shows Talysurf records of tooth pinion surface before and after such a run with E.P. lubricant. It is to be noted that the Talysurf undulations before running, being on a highly magnified scale, correspond with Tomlinson undulation records in the "as shaved" condition shown in Fig. 2.

An alternative to the use of a combination of alloy steels for high duty is the adoption of an alloy steel of high ultimate tensile strength for the pinions, running with a carbon-steel rim having a relatively high carbon content. Opinions have been divided on the point but it does appear that with suitable heat treatment an increase from 0·3 to 0·4 per cent. carbon results in a steel having higher fatigue resistance proportional to the increase in ultimate tensile strength.

In the realm of smaller gears the above considerations have all been largely by-passed by the adoption of case-hardened and ground gears where heavy loading is demanded. Similar developments in marine gearing are greatly handicapped by the difficulty of case hardening a large rim without such growth and distortion as to render subsequent profile grinding a lengthy and costly operation. Alternative approaches which may be more economical for these large gears are nitriding or induction hardening.

A combination which at one time seemed likely to have promising possibilities was the case-hardened and ground pinion in mesh with an alloy-steel rim, but such results as are at present available are not very encouraging, and suggest, perhaps not surprisingly, that the alloy-steel rim is as unaccommodating to a hardened surface as it is to a through-hardened material. Research is still required into the effect of using a suitable E.P. additive and also possibly the alternative employment of higher carbon-steel rims.

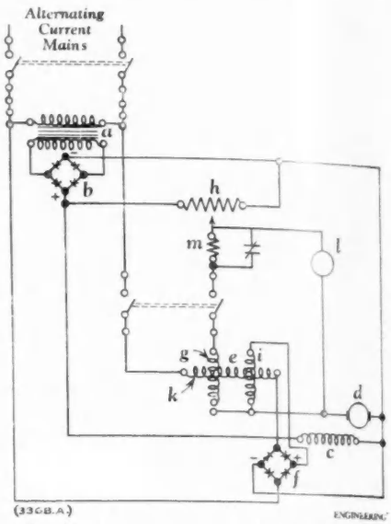
VARIABLE SPEED MOTOR CONTROL

M.T.E. Control Gear Limited, Leigh-on-Sea, Essex, have designed a system of infinitely variable speed control, known as the Vari-Drive, for operation on 50 cycle alternating current mains in conjunction with a direct-current motor. From the user's point of view this system may be considered as a static counterpart of the well-known Ward-Leonard drive.

The system is based on the saturable reactor principle, small direct-current control windings being used to effect large changes in the alternating current output. As will be seen from the diagram reproduced in Fig. 1, a transformer *a* is connected across the alternating current mains; and its output is converted to direct-current in the rectifier *b*, so that full excitation is supplied to the field *c* of the motor *d*. The output of the transductor *e* is also converted by the rectifier *f* and is used for controlling the armature current of the motor *d*. The control winding *g* is energised from the reference potentiometer *h*, the output of which is compared with that from the negative feed-back circuit of the transductor in the coil *i*.

The resultant effect of these control circuits determines the voltage drop across the main winding *k* and this, in turn, determines the voltage which is applied to the direct-current armature *d*. Smooth speed variation over the whole range is effected by adjusting the potentiometer *h*. When, however, rapid speed changes are required the relay *l* comes into operation as a protection to the ballast resistance *m*.

The transductor and rectifiers are mounted on a panel and, as will be seen from Fig. 2, are housed in a fabricated steel cabinet, which is ventilated and provided with a steel door. For motor ratings from ¼ to 2 h.p. the cabinets



a. Transformer.
b. Field and reference rectifier.
c. Motor field.
d. Motor armature.
e. Transductor.
f. Armature rectifier.
g. Control winding.
h. Reference potentiometer.
i. Feed-back coil.
k. Main winding.
l. Relay.
m. Ballast resistance.

Fig. 1. Diagram of M.T.E. Vari-Drive for controlling electric motor speeds.

are arranged for fixing to the wall, those for larger sizes being floor-mounted. Speed adjustment and control is effected by a ventilated rheostat and "on" and "off" switch, which is also contained in a sheet steel box, as shown in Fig. 3. The main switch and fuses are separate.

The direct-current motors used on this system are matched for duty with the Vari-Drive controller and are of the shunt-wound separately excited type with end shield bearings and standard enclosures. They are designed for basic speeds of 2,850, 1,425 or 1,000 r.p.m. with a continuously variable speed range of 15 to 1 and a constant torque characteristic. Units with outputs of 2 h.p. or more are provided with a current limiting device which enables the motor to be switched in at any pre-set speed. On motors up to 1½ h.p. reversing is effected by a switch, but reversing contactors with push button control can be fitted to the larger sizes.

The system described is designed for use on a number of drives, including machine tools, mechanical handling plant and textile machinery. A particular application is that of regulating the rate of feed to disintegrators and pulverising mills. In this case once the rate of feed has been determined it is adjusted automatically by a current transformer or reference signal to maintain a constant through-put. The mill therefore cannot be overloaded or become choked, while a maximum amount of material can be handled without attendance or risk of damage to the machinery.

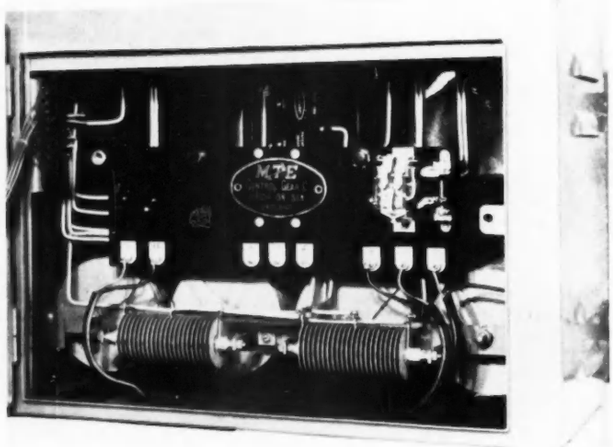


Fig. 2 Equipment panel of Vari-Drive infinitely variable speed control system.

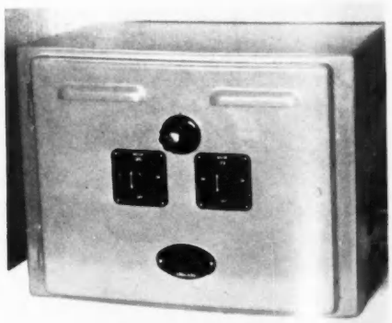


Fig. 3. Control statio

NOTICES OF MEETINGS

Association of Supervising Electrical Engineers

COVENTRY
"Fluorescent Applications," by J. D. Layton. Coventry Branch. Technical College, Coventry. Tues., Jan. 31, 7.15 p.m.
CROYDON
"Atomic Energy," by Dr. A. Hugh. South London Branch. Half Moon Hotel, Broad Green, Croydon. Thurs., Feb. 2, 8 p.m.
LIVERPOOL
"Instrument Transducers," by G. R. Polgreen. Liverpool Branch. Liverpool Engineering Society, 9 The Temple, 24 Dale-street, Liverpool. Fri., Feb. 3, 7.30 p.m.
MANCHESTER
Discussion on "Lightning Conductors." Manchester Branch. Engineers' Club, Albert-square, Manchester. Wed., Feb. 1, 7.30 p.m.

British Institution of Radio Engineers

LIVERPOOL
"Development of a Design for an Angle-Modulation Radio Link," by H. C. Spencer. Merseyside Section. Chamber of Commerce, 1 Old Hall-street, Liverpool, 3. Wed., Feb. 1, 7 p.m.
MANCHESTER
"Design of Battery-Operated Frequency Modulation Receivers," by R. A. Lampitt. North Western Section. College of Technology, Sackville-street, Manchester. Thurs., Feb. 2, 6.30 p.m.

British Interplanetary Society

LONDON
"Portable Breathing Apparatus," by T. D. Bourdillon. Caxton Hall, Victoria-street, S.W.1. Sat., Feb. 4, 6 p.m.

British Kinematograph Society

LONDON
"Capabilities of 16 mm. Film," by Peter Hadingham. Holborn Town Hall, High Holborn, W.C.1. Wed., Feb. 1, 7.15 p.m.

Building Centre

LONDON
Film on "Electric Wiring on the Ring Circuit System," sponsored by the British Electrical Development Association. 26 Store-street, W.C.1. Wed., Feb. 1, 12.45 p.m.

Chemical Society

LONDON
Symposium on "Recent Advances in the Chemistry of Colouring Matters." Royal Institution, 21 Albemarle-street, W.1. Thurs., Feb. 2, 2.30 p.m. and 7.30 p.m.
ABERDEEN
"Analytical Chemistry, Chemical Analysis and the Analyst," by R. C. Chirnside. Aberdeen Branch. Marischal College, Aberdeen. Fri., Feb. 3, 7.30 p.m.
BRISTOL
"Operational Research," by D. Hicks. Bristol Branch. Chemistry Department, The University, Bristol. Thurs., Feb. 2, 5.15 p.m.
HULL
"Designing New Rubber-Like Polymers," by Professor G. Gee. Hull Branch. Chemistry Department, The University, Hull. Thurs., Feb. 2, 6 p.m.
SOUTHAMPTON
"Magnetism and the Structure of Inorganic Molecules," by Professor R. S. Nyholm. Southampton Branch. Chemistry Department, The University, Southampton. Fri., Feb. 3, 5 p.m.

Illuminating Engineering Society

CARDIFF
"Black Light: Its Effect and Applications," by H. L. Privett. Cardiff Centre. Offices of the South Wales Electricity Board, The Hayes, Cardiff. Thurs., Feb. 2, 5.45 p.m.
EDINBURGH
"Progress in Lamps and Lighting," by H. R. Ruff and R. V. Mills. Edinburgh Centre. 14 St. Andrews-street, Edinburgh, 2. Wed., Feb. 1, 6.15 p.m.
GLASGOW
"Progress in Lamps and Lighting," by H. R. Ruff and R. V. Mills. Glasgow Centre. 39 Elmbank-crescent, Glasgow, C.2. Thurs., Feb. 2, 6.30 p.m.
NOTTINGHAM
"History of Mine Lamps," by Miss H. M. Maurice. Nottingham Centre. Offices of the East Midlands Electricity Board, Smithy-row, Nottingham. Thurs., Feb. 2, 6 p.m.

Incorporated Plant Engineers

LEEDS
"An Introduction to Atomic Energy," by J. A. Dixon. West and East Yorkshire Branch. The University, Leeds. Mon., Jan 30, 7.30 p.m.
LEICESTER
"Staff Location and Time Systems," by E. O. Chapman. Leicester Branch. College of Art and Technology, The Newarkes, Leicester. Wed., Feb. 1, 6.30 p.m.
PETERBOROUGH
"Prevention of Industrial Accidents," by T. W. Thompson. Peterborough Branch. Grand Hotel, Peterborough. Thurs., Feb. 2, 7.30 p.m.

Institute of Fuel

LONDON
"The Harnessing of Nuclear Power for Industry," by J. L. Gillams. Institution of Civil Engineers, Great George-street, S.W.1. Wed., Feb. 1, 5.30 p.m.*
CARDIFF
"Research at the National Coal Board," by Dr. W. Idris Jones. South Wales Section. South Wales Institute of Engineers, Park-place, Cardiff. Fri., Feb. 3, 6 p.m.

Institute of Industrial Supervisors

GLASGOW
"Mechanical Handling Contribution to Production," by R. E. Pirie. Glasgow Section. 39 Elmbank-crescent, Glasgow, C.2. Wed., Feb. 1, 7.30 p.m.

Institute of Marine Engineers

LIVERPOOL
"The Construction of the Ship," by G. Ridley Watson. Junior Section. Mersey and North Western Section. Old Swan Technical College, Liverpool. Mon., Jan. 30, 7 p.m.

Institute of Welding

LONDON
Film Display. North London Branch. Exhibition Hall, Babcock & Wilcox, Ltd., Salisbury Square House, Fleet-street, E.C. Wed., Feb. 1, 6.30 p.m.* (Tickets needed.)
NEWCASTLE-UPON-TYNE
"Fabrication of Power-Station Plant," by W. G. Brown. North Eastern Branch. Merseyside) Branch. Neville Hall, Westgate-road, Newcastle-upon-Tyne. Thurs., Feb. 2, 7 p.m.

Institution of Chemical Engineers

BIRMINGHAM
Annual General Meeting, at 2.30 p.m. "Practical Aspects of Electrostatic Precipitator Operation: Experiments on Pilot Plant," by A. Little, at 3 p.m. Midlands Branch. Midlands Institute, Birmingham. Sat., Feb. 4.

Institution of Civil Engineers

LONDON
"Pimlico District Heating Undertaking: Costs and Financial Results," by B. Donkin, C. M. Johnston and E. Ockenden. Great George-street, S.W.1. Tues., Jan. 31, 5.30 p.m.*

Institution of Electrical Engineers

LONDON
"Pimlico District Heating Undertaking: Costs and Financial Results," by B. Donkin, C. M. Johnston and E. Ockenden. Joint Meeting. Institution of Civil Engineers, Great George-street, S.W.1. Tues., Jan. 31, 5.30 p.m.*
Discussion on "The Design and Use of Electrical Measuring Instruments for Arduous Conditions of Service," to be opened by C. A. Oldham and G. N. Harding. Savoy-place, W.C.2. Tues., Jan. 31, 5.30 p.m.*
"The Potentialities of Railway Electrification at the Standard Frequency," by E. L. E. Wheatcroft and H. H. C. Barton. Savoy-place, W.C.2. Thurs., Feb. 2, 5.30 p.m.*
EDINBURGH
"Colour Television," by Dr. G. N. Patchett. South East Scotland Sub-Centre. Carlton Hotel, North Bridge, Edinburgh. Tues., Jan. 31, 7 p.m.
GLASGOW
"Equipment of Instrumental Accuracy for the Recording and Reproduction of Electrical Signals, Using Cinematograph Film," by H. McGregor Ross. South West Scotland Sub-Centre. 39 Elmbank-crescent, Glasgow, C.2. Wed., Feb. 1, 7 p.m.
NEWCASTLE-UPON-TYNE
"The Recent Research for and Salvage of the Comet Aircraft near Elba," by Commander C. G. Forsberg and G. G. MacNeice; and "The Tyne Tunnel," by J. Kell. North Eastern Centre. The Liberal Club, Newcastle-upon-Tyne. Fri., Feb. 3, 7 p.m.
PORTSMOUTH
"Problems of Hydro-Electric Design in Mixed Thermal-Hydro-Electric Systems," by T. G. N. Haldane and P. L. Blackstone. Southern Centre. College of Technology Extension, Anglesea-road, Portsmouth. Wed., Feb. 1, 6.30 p.m.

Institution of Heating and Ventilating Engineers

NEWCASTLE-UPON-TYNE
"Gravity Pipe Sizing Extraordinary," by T. H. F. Holman. North East Coast Branch. Neville Hall, Westgate-road, Newcastle-upon-Tyne. Tues., Jan. 31, 6.30 p.m.
NOTTINGHAM
"Small-House Heating," by N. Jackson. East Midlands Branch. College of Arts and Crafts, Waverley-street, Nottingham. Wed., Feb. 1, 6.45 p.m.

Institution of Highway Engineers

LONDON
"The Engineer and Accidents on the Roads," by O. W. Gilmour; and "Modern Road Surfaces," by J. H. H. Wilkes. Institution of Structural Engineers, 11 Upper Belgrave-street, S.W.1. Fri., Feb. 3, 5.30 p.m.

Institution of Mechanical Engineers

LONDON
Discussion: "Electrical Control of Machine Tools with Particular Reference to Electronics." Industrial Administration and Engineering Production Group. Wed., Feb.1, 6.45 p.m.*
DERBY
"Some Engineering Problems at High-Speed Flight," by R. F. Creasy. East Midlands Branch and Derby A. D. Centre. Rolls-Royce Welfare Hall, Nightingale-road, Derby. Mon., Jan. 30, 7.15 p.m.
MANCHESTER
"The Production of Motor-Car Bodies and Similar Steel Pressings," by S. Neville. North Western Branch. Engineers' Club, Albert-square, Manchester. Thurs., Feb. 2, 6.45 p.m.

Institution of Production Engineers

DUDLEY
"Argonaut Welding Process," with film, by K. Purdy. Wolverhampton Section. Dudley Technical College, The Broadway, Dudley. Wed., Feb. 1, 7.15 p.m.
HALIFAX
"Computer-Controlled Machine Tools," by H. Ogden. White Swan Hotel, Halifax. Mon., Feb. 6, 7.15 p.m.
LUTON
Discussion on "Electronic Computers." Luton Section. Offices of S.K.F., Ltd., Luton. Tues., Jan. 31, 7.30 p.m.

Institution of Structural Engineers

MIDDLESBROUGH
"Foundations, Underpinning and Structural Problems at the *Daily News* Building," by F. W. Slatter and A. Brown. Cleveland Scientific and Technical Institution, Middlesbrough. Tues., Jan. 31, 6.30 p.m.

Junior Institution of Engineers

LONDON
Film Evening. Fri., Feb. 3, 7 p.m.
BIRMINGHAM
Presidential Address by O. D. Smith. Midland Section. James Watt Memorial Institute, Great Charles-street, Birmingham. Wed., Feb. 1, 7 p.m.

Manchester Association of Engineers

MANCHESTER
"Pneumatic Handling of Powdered Materials in the Food Industries," by R. W. Allen and W. J. Farrand. Engineers' Club, Albert-square, Manchester. Fri., Feb. 3, 6.45 p.m.

Modular Society

LONDON
Report of representatives of the Building Research Station and British Standards Institution upon their joint programme of research in modular co-ordination under the auspices of the European Productivity Agency. Royal Society of Arts, John Adam-street, Adelphi, W.C.2. Mon., Feb. 6, 7.30 p.m.

Reinforced Concrete Association

LIVERPOOL
Film Evening. North Western Branch. Liverpool Engineering Society, 9 The Temple, 24 Dale-street, Liverpool. Wed., Feb. 1, 6.30 p.m.*

* An asterisk is placed where it is understood that tea is available prior to the time stated.

FORTHCOMING EXHIBITIONS AND CONFERENCES

This list, arranged chronologically, appears in the last issue of each month. Events appearing for the first time, and alterations of dates, places, etc., are indicated by an asterisk (•). Particulars of exhibitions and conferences not included below may have appeared in ENGINEERING, *November* 25, *page* 741; *or December* 30, *page* 901. *Organisers are invited to send to the Editor particulars of coming events as soon as arrangements are made.*

Electronics and Productivity Exhibition and Conference.—Mon., Feb. 6, to Thurs., Feb. 9, at the Kelvin Hall, Glasgow. Organised by the South of Scotland Electricity Board, 351 Sauchiehall-street, Glasgow, C.2.

Power Farming Conference, Sixth National—Tues., Feb. 7, to Thurs., Feb. 9, at the Winter Gardens, Bournemouth, Hants. Apply to the organiser, National Power Farming Conference, Dorset House, Stamford-street, London, S.E.1. Tel. WATerloo 3333.

•"**Silicones for Industry" Exhibition.**—Tues., Feb. 7, to Sat., Feb. 18, at the Tea Centre, Lower Regent-street, London, S.W.1. Organised by Midland Silicones Ltd., 19 Upper Brook-street, London, W.1. Tel. GROsvenor 4551.

Winter Concreting Symposium.—Sun., Feb. 12, to Fri., Feb. 17, at Copenhagen. Apply to the organising secretary, Rilem Symposium 1956, c/o The Danish National Institute of Building Research, 20 Borgergade, Copenhagen, K, Denmark.

Hardware Trades Fair.—Mon., Feb. 20, to Fri., Feb. 24, at the Royal Horticultural Society's Old and New Halls, Vincent-square and Greycoat-street, London, S.W.1. Apply to the organising secretary, Hardware Trades Fair, 74 Holland Park, London, W.11. Tel. PARk 7723.

Business Efficiency Exhibition.—Mon., Feb. 20, to Sat., Feb. 25, at Bingley Hall, Birmingham. Organised by the Office Appliance and Business Equipment Trades Association, 11-13 Dowgate-hill, Cannon-street, London, E.C.4. Tel. CENtral 7771.

British Industries Fair.—Wed., Feb. 22, to Fri., Mar. 2 (including British Toy Fair), at Earl's Court, London, S.W.5. (Organised jointly with British Toy Manufacturers' Association.) Also Mon., April 23, to Fri., May 4, at Olympia, London, W.14, and at Castle Bromwich, Birmingham. Apply to British Industries Fair, Ltd., 9 Kingsway, London, W.C.2. Tel. COVent Garden 1461; or to general manager, B.I.F., 95 New-street, Birmingham, 2. Tel. Midland 5021.

•**Leipzig International Fairs.**—*Spring Fair and Technical Fair:* Sun., Feb. 26, to Thurs., Mar. 8, at Leipzig. *Autumn Fair:* Sun., Sept. 2, to Sun., Sept. 9, at Leipzig. *Agents:* Leipzig Fair Agency in Great Britain, 127 Oxford-street, London, W.1. Tel. GERrard 0357.

•**National Caravan Council's Second Annual Convention and Exhibition.**—Tues., Mar. 6, to Fri., Mar. 9, at Brighton. Organised by the National Caravan Council, 8 Clarges-street, London, W.1. Tel. GROsvenor 1532.

•**National Association of Corrosion Engineers, Conference.**—Mon., Mar. 12, to Fri., Mar. 16, at New York. Offices of the Association: 1061 M and M Building, Houston 2, Texas, U.S.A.

•**Modern Techniques in Chemical Plant Construction, Symposium and Exhibition.**—Wed., Mar. 21, at The University, Edgbaston, Birmingham, 15. Organised by the Midland Graduate, and Students' Section of the Institution of Chemical Engineers Apply to Mr. M. G. D. Bailey, 1 Wentworth-gate, Harborne Birmingham, 17.

•**Swiss Industries Fair.**—Sat., April 14, to Tues., April 24, at Basle, Switzerland. Apply to the Economic Division, Swiss Legation, 18 Montagu-place, Bryanston-square, London, W.1. Tel. PADdington 0701.

•**Industrial Co-Partnership Conference.**—Tues., April 17, to Fri., April 20, at the Hydro Hotel, Peebles, Scotland. Organised by the Industrial Co-Partnership Association, 36 Victoria-street, London, S.W.1. Tel. ABBey 3342.

•**Castings Congress and Foundry Show (60th).**—Thurs., May 3, to Wed., May 9, at the Convention Hall, Atlantic City, N.J., U.S.A. Theme: "The Foundry of To-morrow." Organised by the American Foundrymen's Society, Golf and Wolf-roads, Des Plaines, Ill., U.S.A.

•"**Habitation 56.**"—Sat., May 19, to Sun., June 3, corner of Boulevard General Wahis and Avenue Leopold III, Brussels. Combined home and building exhibition, sponsored by the Brussels Chamber of Commerce Building Group. *Agents:* Willoughby and Young, 6a Smith-street, London, S.W.3. Tel. SLOane 1594.

•**Light Metals Convention, Third International.**—Thurs., June 7, to Sat., June 9, at the Montanistische Hochschule, Leoben, Austria. Information obtainable from the organising committee, Institut für Metallkunke, Montanistische Hochschule, Leoben, Steiermark, Austria.

•**New York Lamp Show.**—Sun., July 8, to Fri., July 13, at New Yorker Hotel, New York. Apply to Mr. George F. Little, 220 Fifth-avenue, New York 1.

•**Industrial Co-Partnership Association's 26th Summer Conference.**—Fri., July 13, to Mon., July 16, at Girton College, Cambridge. Organised by the Industrial Co-Partnership Association, 36 Victoria-street, London, S.W.1. Tel. ABBey 3342.

•**Applied Mechanics, Ninth International Congress.**—Wed., Sept. 5, to Thurs., Sept. 13, at Brussels. Apply to the general secretariat, Université Libre de Bruxelles, 50 Avenue F. D. Roosevelt, Brussels, Belgium.

•**Chemists' Trade Fair, International (INDROFA).**—Sun., Oct. 7, to Sun., Oct. 14, at Dusseldorf. Organised by the Nordwestdeutsche Ausstellungs-Gesellschaft m.b.H. (NOWEA), Ehrenhof 4, Dusseldorf, Germany.

•**United States World Trade Fair.**—Sun., April 14, to Sat., April 27, 1957, at the New York Coliseum, New York. Managers: The Charles Snitow Organisation, Inc., 331 Madison-avenue, New York 17. Information may be obtained from the British Commonwealth Chamber of Commerce in the United States, 677 Fifth-avenue, New York, 22 and from the Fair's British and Commonwealth Office, Dudley House, 36 and 38 Southampton-street, London, W.C.2. Tel. TEMple Bar 8947.

THE HUMAN ELEMENT

Towards a mammoth union—Case histories at a conference—Can unions learn from the old guilds?—Gesture of confidence to the railwaymen.

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A.E.U. Merger Proposal

The Amalgamated Engineering Union have tabled a proposal for the merging of 20 trade unions into a group that would be the biggest in the country. Originally, 31 unions were approached but only 19 agreed to send representatives to a meeting to be held in London on February 29. Among those who declined were the United Society of Boilermakers, Shipbuilders and Structural Workers, and the United Patternmakers Association. The Electrical Trades Union and the Amalgamated Union of Foundry Workers have accepted the A.E.U.'s invitation, as have unions representing plumbers, constructional engineering workers, brass workers, coppersmiths, blacksmiths, sheet metal workers, draughtsmen and firemen.

If the proposal is accepted, a much more closely-knit approach to their problems is expected from workers in the metal and engineering industries. There is also the possibility of a shift towards a more militant left-wing policy, already being followed by the E.T.U., the Foundry Workers, and the A.E.U. themselves. The merger is therefore unlikely to promote peace in the trade union movement, although it would greatly increase the bargaining power of the craft unions *vis-à-vis* the T.G.W.U. in the engineering industry as well as within the Trades Union Congress.

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Discipline and Full Employment

Nearly 900 people attended the regional conferences of the Institute of Industrial Supervisors in 1955, and their deliberations are now available in booklet form under the heading of "Discipline and Full Employment." A study of the proceedings illustrates what has been growing more apparent of recent years, namely, that however interesting general subjects may be for discussion at conferences, when they are reduced to print the special subjects are of much greater value to the general reader.

The outstanding contributions in these conferences, for example, came from those speakers who were prepared to get down to special cases and say: "This is what we have done. We have had some failures and a good many successes in maintaining a high level of discipline. I'm going to tell you about both." All industrial conferences are to a certain extent a meeting of the enlightened and the converted. The diehards take care to stay away in most cases. Broad principles are generally agreed and should be quickly stated. What the progressive-minded trade unionist or manager wants is some inkling of how broad principles can be applied to his particular problems; he gets most help from other peoples experience—from the mistakes as well as the successes. Anything which can be done to bring to the fore such case studies in the literature of management and in the programmes of conferences should be encouraged.

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This Fashionable Impudence

Rudeness has been for some time a commercial asset for those who seek by one means or another to keep their names before the public. Last week it was joined by impudence as a commercial virtue, which is not surprising for they are closely related. When a Court ruled that a butcher could take his meat away from Smithfield market without using a licensed porter, the local organiser of the T.G.W.U. had this to say: "The judge said he could, the butcher said he would, we said he couldn't—and he didn't." It will be recalled that the bumarees (as the middle porters are called at Smithfield) are organised by that union, and it is therefore in a monopoly position. There is a direct clash here between the right of an individual and the monopoly position of the union. The latter has chosen to flaunt its power.

This is a thoroughly bad situation in principle. It would be wrong to go to the other extreme and make a systematic attempt to break a union by bringing in unorganised labour, but there is something wrong when both a licensing system and a monopoly union are united against an individual's right to trade. No doubt the ancient guilds of London and elsewhere tried similar manoeuvres to maintain a similar monopoly position in the Middle Ages. To-day there is free trading (up to a point) in most parts of London but the guilds are gone except as social organisations. That fact might have a lesson for those who to-day abuse power.

★ ★ ★

Railwaymen's Seven Per Cent.

The British Transport Commission's offer to raise the wage rates of railwaymen by 7 per cent. has taken the industrial world by surprise—unions and employers alike. Sir Brian Robertson, chairman of the B.T.U., justified having gone so far towards meeting the union's claims—the N.U.R. had asked for 10 per cent.—on the ground that the Commission's first objective is "a loyal, efficient and contented staff." In addition to the rise in wages there is an offer to improve working conditions by reducing the working hours of certain grades, increasing overtime rates and instituting a sick pay scheme.

There will doubtless be strong criticism of the B.T.C.'s action, which has obvious implications in relation to other wage claims now being negotiated. Yet their attitude is understandable in the light of the vast modernisation programme now under way, the successful realisation of which depends on the co-operation of the unions concerned. Sir Brian believes that a contented staff is a valuable asset, and that the key to lower costs lies in improved efficiency and modern plant and machinery. This belief is shared by most of the "growth" industries in the country, some of which instance the high average earnings of their employees as evidence of this success. Higher pay will not, however, either secure higher efficiency or contentment unless it is part and parcel of good management. Nor will the most up-to-date machines raise productivity by an amount proportionate to their cost unless management is efficient and its relations with labour are good.

The B.T.C. have moved wisely, in circumstances that permitted little else. It is now up to the management and to the workers to show the public that the real costs of rail transport can be lowered, by efficient organisation and hard work.

★ ★ ★

STIMULUS TO PRODUCTIVITY

International Essay Competition

To encourage young people to search for and study methods of increasing production, the British Productivity Council is co-operating with the European Productivity Agency in promoting an international prize essay competition. Five prizes will be awarded in each participating country by the Agency. These will consist of a visit to Paris and a tour of about ten days' duration in at least one European country.

The competition is limited to students who were under 27 years of age on December 31, 1955, and who are attending courses of study in industrial or technical subjects (including economics and agriculture (approved by a recognised education body.

Official entry forms (which must be used) and further information may be obtained, free of charge, from the British Productivity Council, 21 Tothill-street, London, S.W.1, at any time up to February 6, and essays must reach the Council not later than March 7, 1956.

Work is in progress on the Institute of Marine Engineers' National War Memorial Building, which should be in use as the Institute's headquarters by the end of 1957. To help pay for the project a new appeal has been launched.

A PRACTICAL WAR MEMORIAL

Progress on Institute of Marine Engineers' New Headquarters

The membership of the Institute of Marine Engineers, which approaches 10,000, is now increasing at a rate greater than ever before; 1,000 members were elected during 1955 alone. It is not surprising therefore that their present accommodation at 85 The Minories, London, E.C.3, is inadequate, and that the completion of their new headquarters, now under construction in Fenchurch-street, is impatiently awaited. Already the foundations have been laid, and rapid progress is being made. It has also been announced that a new appeal is being launched to aid the financing of the scheme.

The building is to serve as a war memorial to commemorate in a practical manner the 3,458 marine engineers who lost their lives during the war, and it is hoped that it will be ready before September 1957, the date originally intended. It will be one of the highest buildings in London and will comprise two sections, the Institute itself and offices. A Memorial Hall entered from the first-floor vestibule and having seating for about 400, will occupy the centre of the building, and will thus be well insulated from the noise of traffic. The building itself will be of imposing appearance, as can be seen from the accompanying architect's drawing, and will embody a tower section, in which the Institute library will be housed.

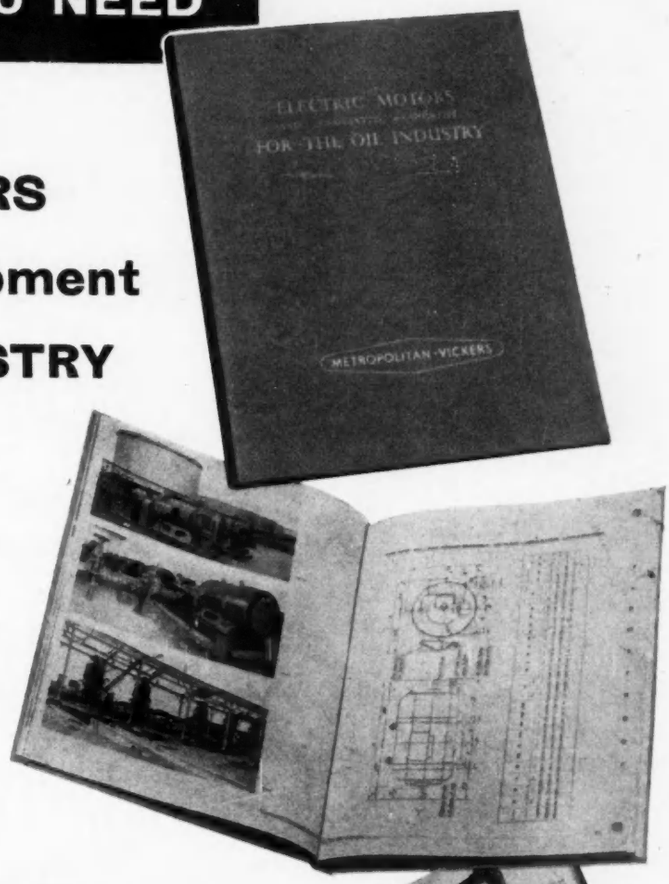
★ ★ ★

NEW REACTORS AT HARWELL

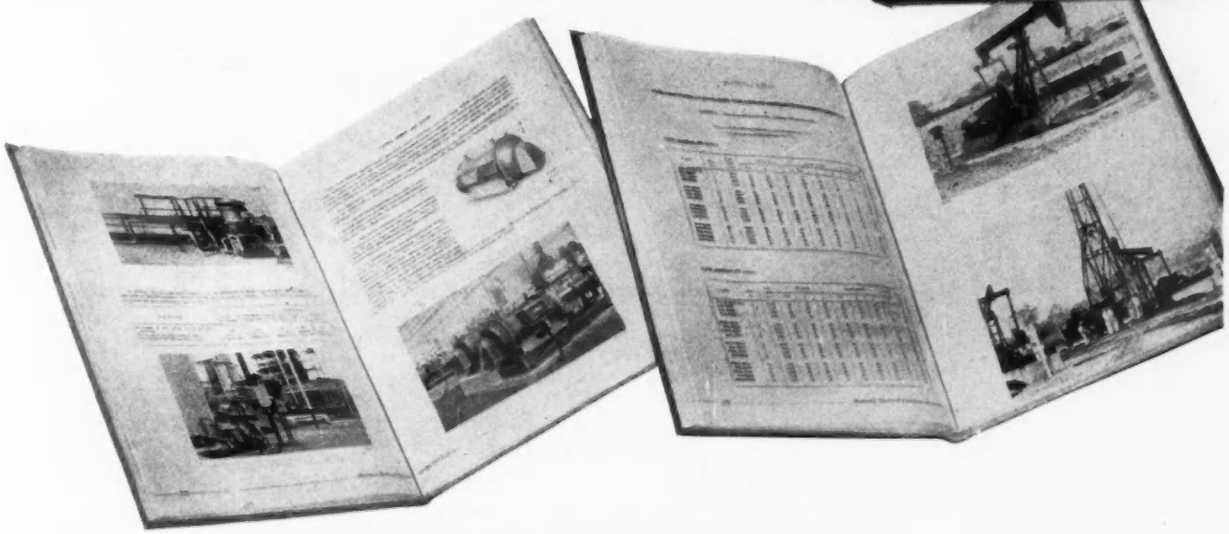
It has been announced by the United Kingdom Atomic Energy Authority that two new reactors have just been brought into operation at Harwell. These reactors are ZETR (Zero Energy Thermal Reactor) and ZEUS (Zero Energy Uranium System). ZEUS has been built as a low-power (100 W.) model for examining problems likely to arise at Dounreay. ZETR has not previously been mentioned and is the first indication that Harwell is considering homogeneous reactors, the use of which for power generation depends on the availability of considerable fissile material for starting up. These reactors employ a nuclear fuel circulating in a solution of either ordinary or heavy water, and it is believed that the chemical process can ultimately be made continuous.

A PUBLICATION YOU NEED

ELECTRIC MOTORS
and associated equipment
FOR THE OIL INDUSTRY



Metrovick Engineers have made an extensive study of motor, control gear and switchgear problems in the Oil Industry. Results of this experience are crystallised and arranged for easy reference in this fully illustrated 197 page book. Information given includes a selected choice of motors and associated equipment both flame-proof and non-flame proof, with rating lists and dimension tables. Useful general details of motor drives and maintenance are also included.
Senior personnel associated with oil and chemical industries are invited to write for publication 7765/2.



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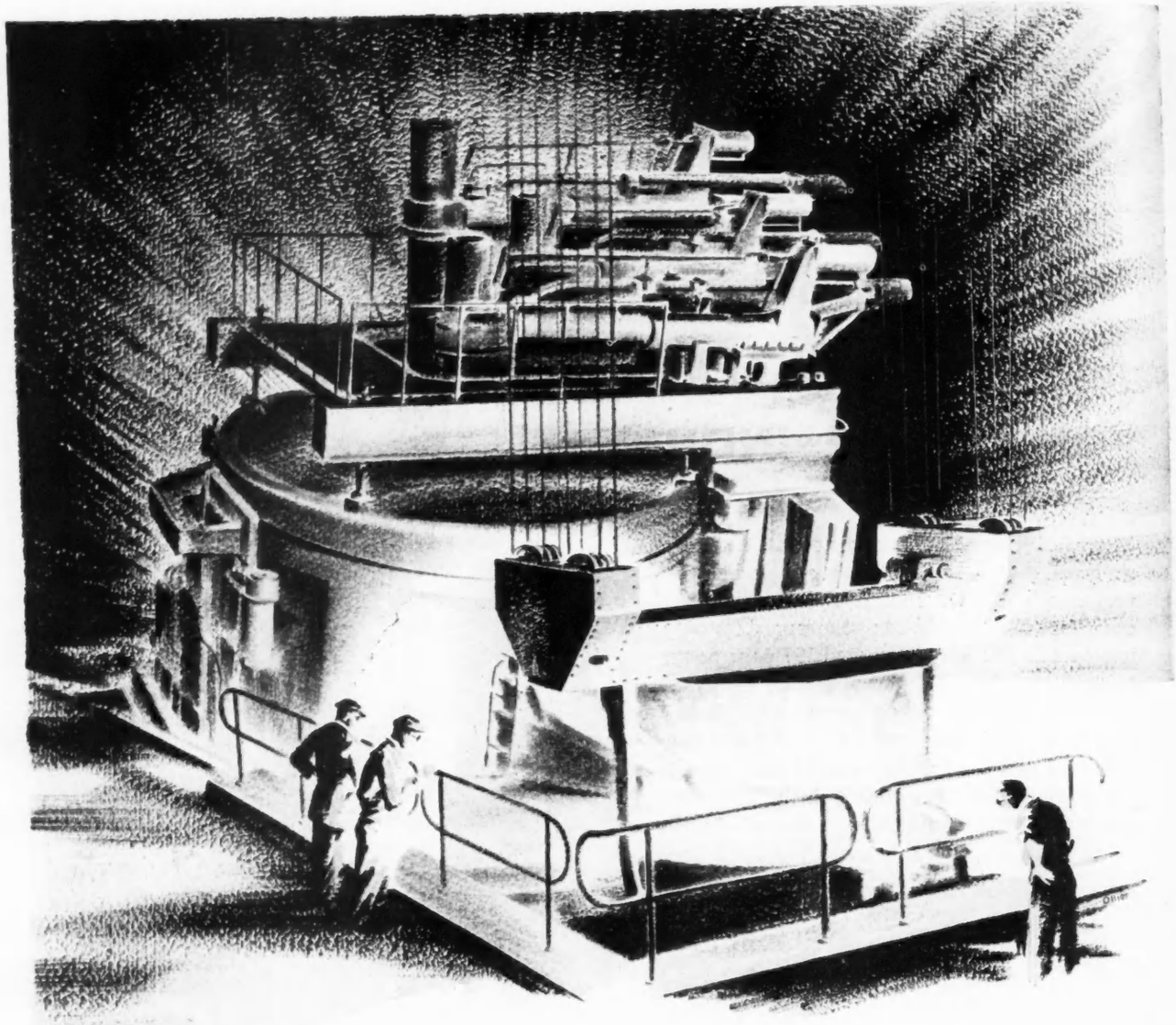

A 60 TON ARC FURNACE

Electric steel making at the Stocksbridge Works of Samuel Fox has been doubled by the installation of a furnace melting 60-ton casts.

The contribution it has to make to industrial developments can be measured far beyond the physical details of its capabilities and output. It will help to satisfy the ever-increasing demands of the engineering industries for special steels.

This furnace has thus an important role to play in the national economy. It is a symbol of confidence in British industry.

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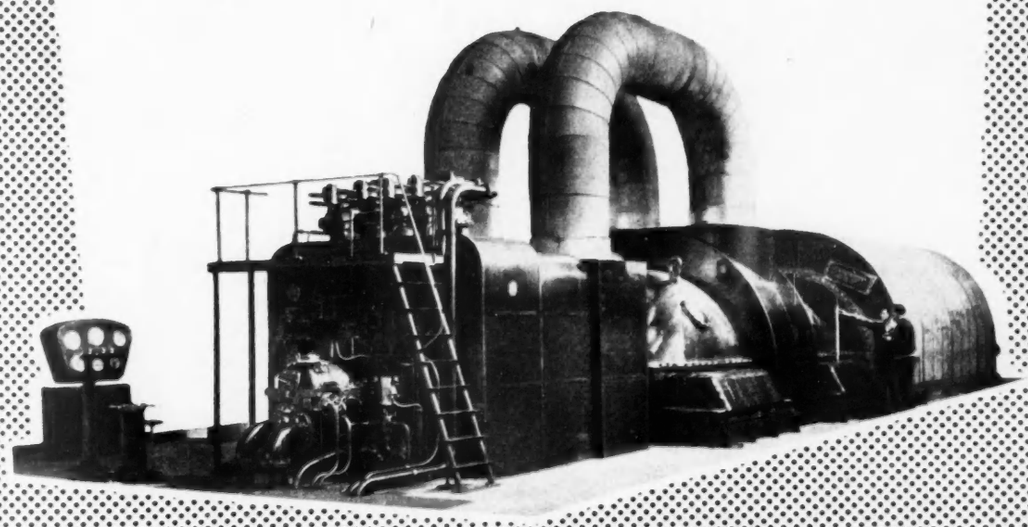

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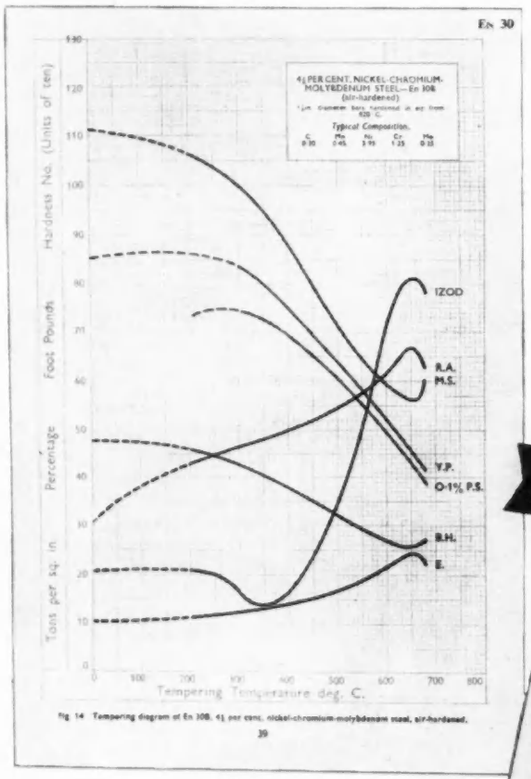
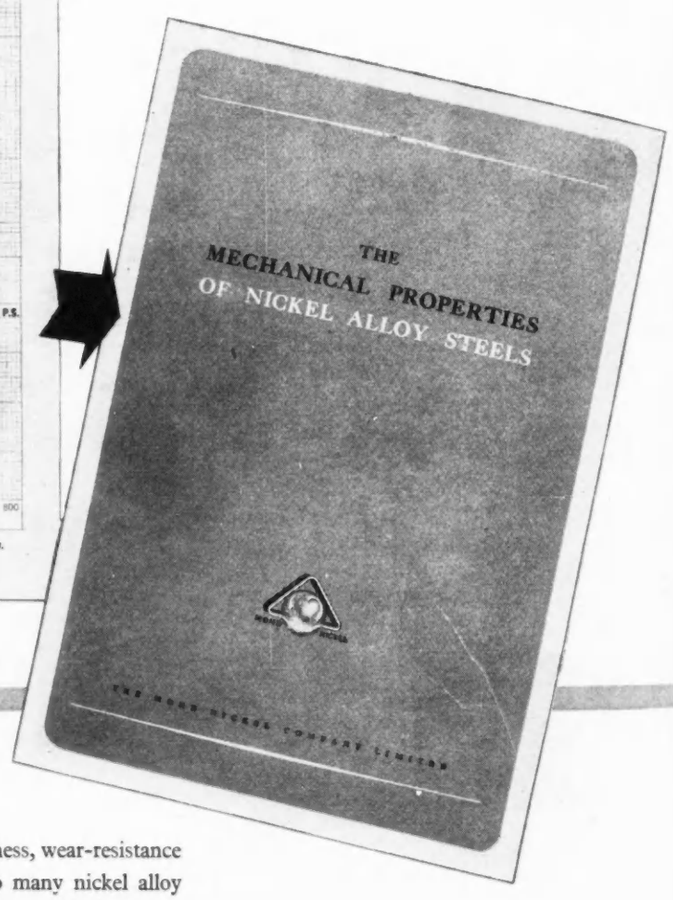


Fig. 14 Tempering diagram of En 30B, 4¼ per cent. nickel-chromium-molybdenum steel, air-hardened.



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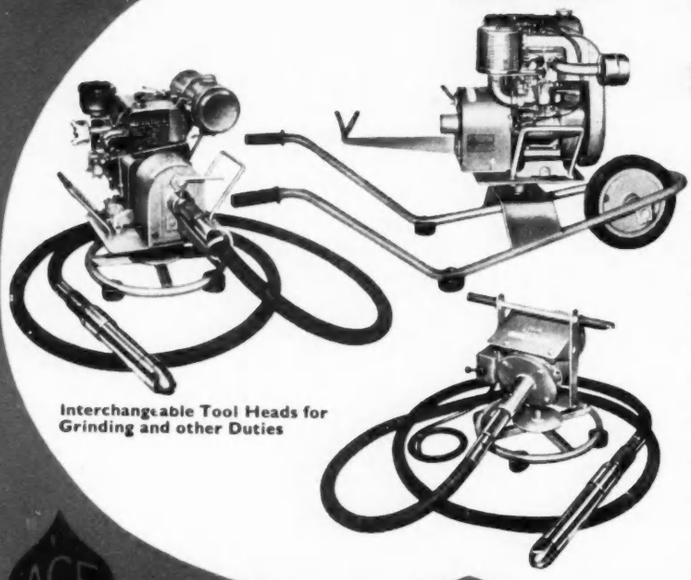

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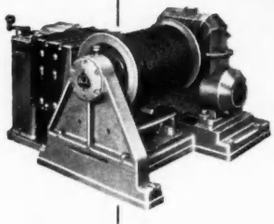

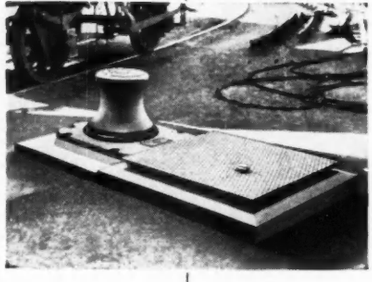

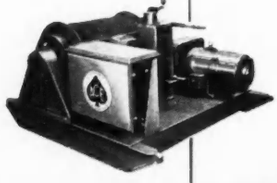

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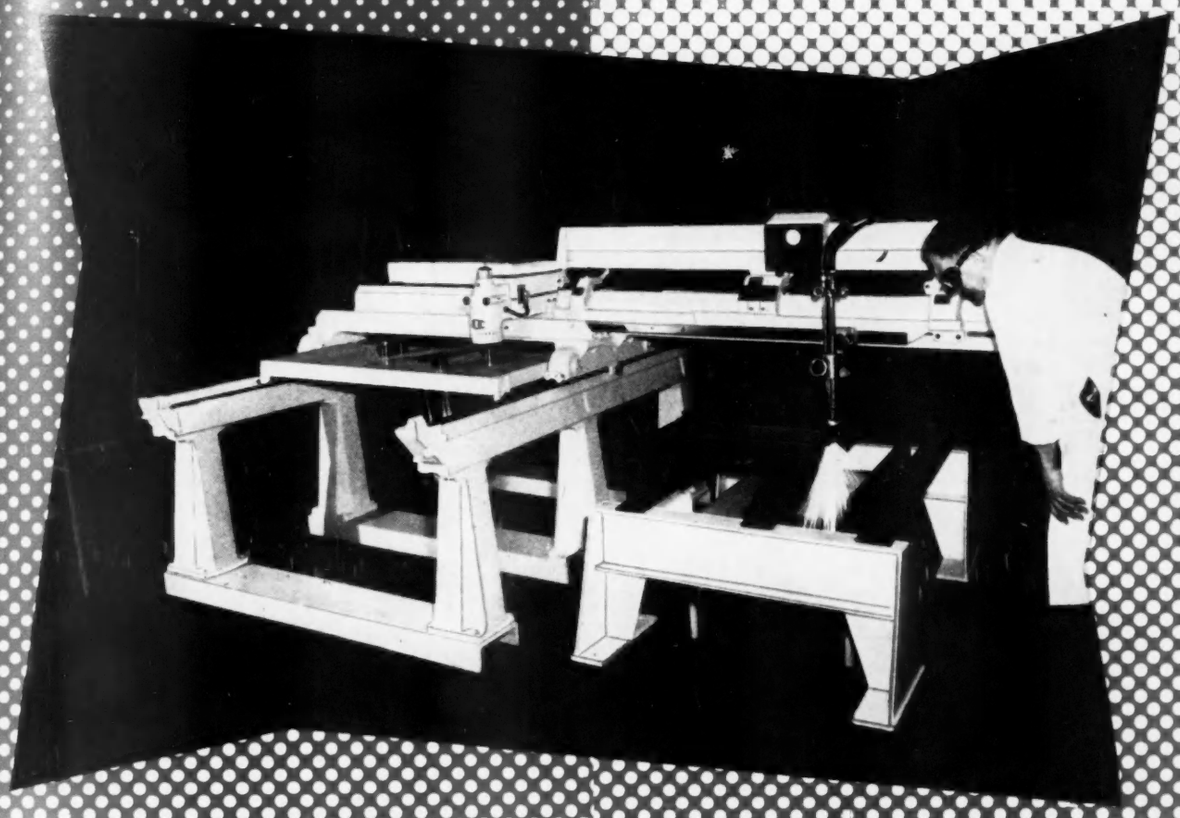

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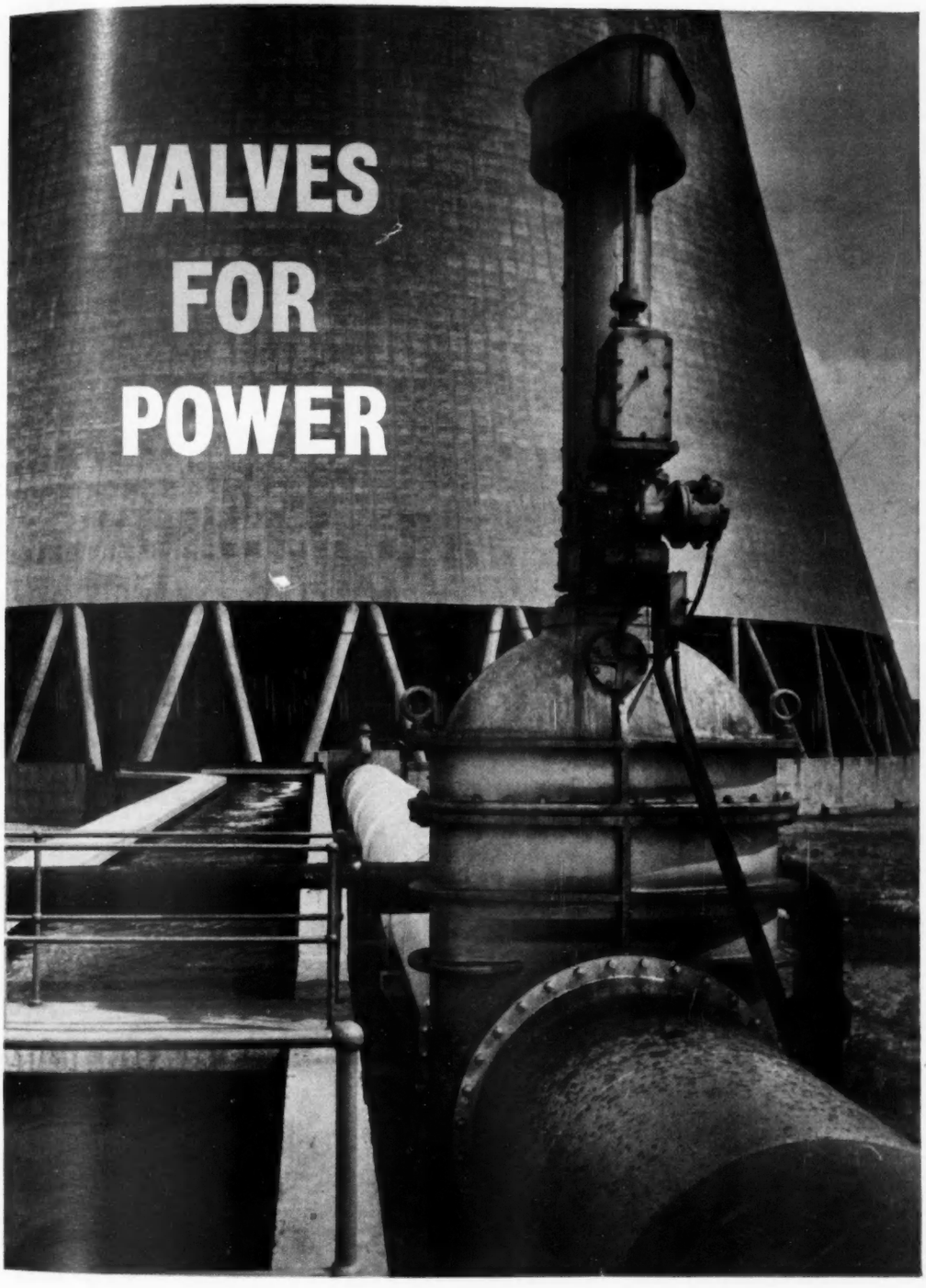

The adjoining list shows the allocation of over 1000 Blakeborough power operated circulating water valves, supplied or ordered for generating stations of the Central Electricity Authority over the past few years. The majority of these valves are above 20 in. bore, and nearly half are in the 40 in. to 90 in. size range. This is one section only of the vast amount of valve work with which we have been entrusted for the C.E.A. programme to date, covering a wide variety of types for circulating water and feed systems, condenser services, and other auxiliaries. The many thousands of valves involved, in connection with upwards of 70 stations, represent the largest single contribution in this class of equipment for the low pressure side.

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Acton Lane 'B'	34
Agecroft 'B'	10
Bankside 'B'	10
Barking 'C'	47
Battersea 'B'	6
Belvedere	16
Blackburn	12
Blyth	30
Bold 'B'	5
Braehead *	16
Brighton 'B'	4
Brunswick Wharf	29
Carmarthen Bay	33
Carrington	27
Castle Donington	42
Chadderton 'B'	37
Cliff Quay	6
Connahs Quay	9
Deptford East	11
Drakelow	58
Fulham	10
Fleetwood	3
Goldington	52
Huncoat	16
Hams Hall 'C'	22
Ince	16
Littlebrook 'C'	24
Marchwood	20
Northampton	4
North Tees 'C'	26
Poole	30
Plymouth 'B'	6
Portishead 'B'	34
Portsmouth	16
Rogerstone	9
Roosecote	8
Rotherham	4
Rye House	28
Skelton Grange	30
Staythorpe	16
Stella North	48
Stella South	36
South Denes	4
Tilbury	31
Thornhill	34
Wakefield 'B'	18
Walsall	8
Westwood	8
Willington	37
Woolwich	10

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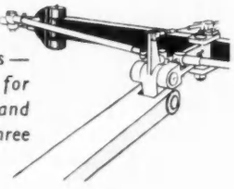
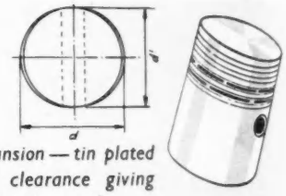
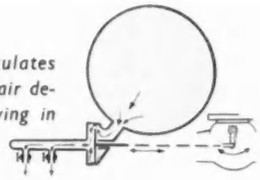


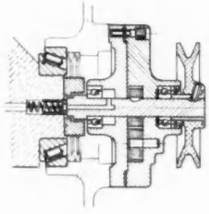
Ovalised pistons for uniform expansion—tin plated for reduced clearance giving safer and better 'run in.'



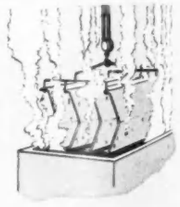
Fuelmiser — regulates engine speed to air demand — 30% saving in fuel consumption —reduces wasteful unloader operation.



Permanently primed, positive displacement gear type oil pump — high pressure lubrication including small ends at all running speeds.



Body parts bonderised for protection against rust — spray finished in oil and weather resistant high gloss enamel.



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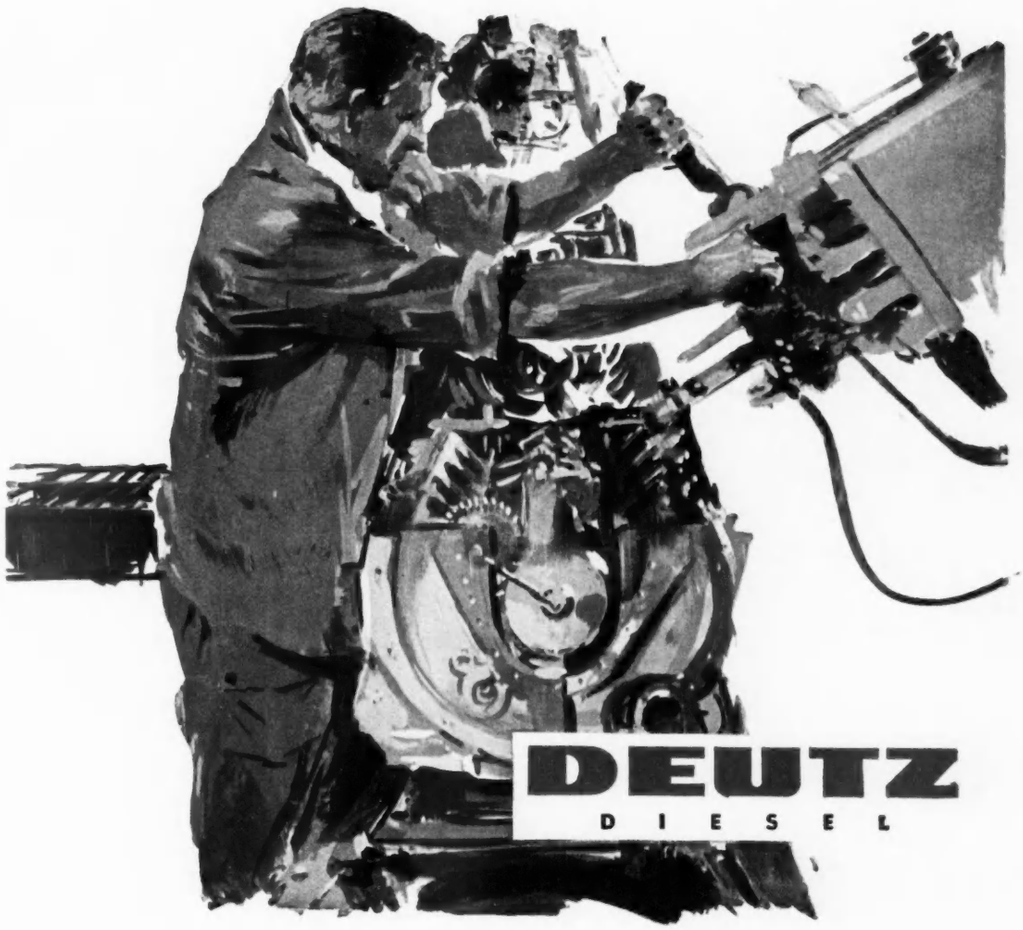

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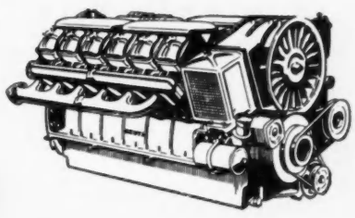

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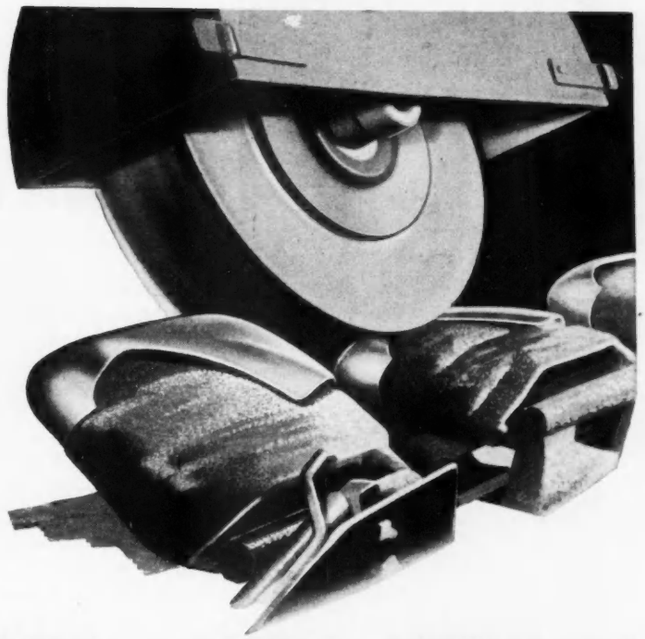

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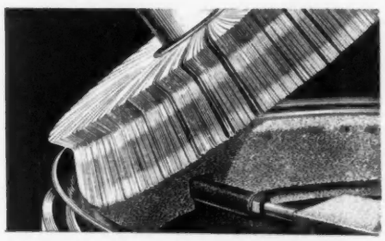

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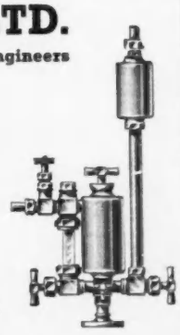

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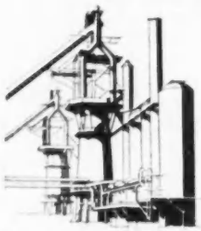

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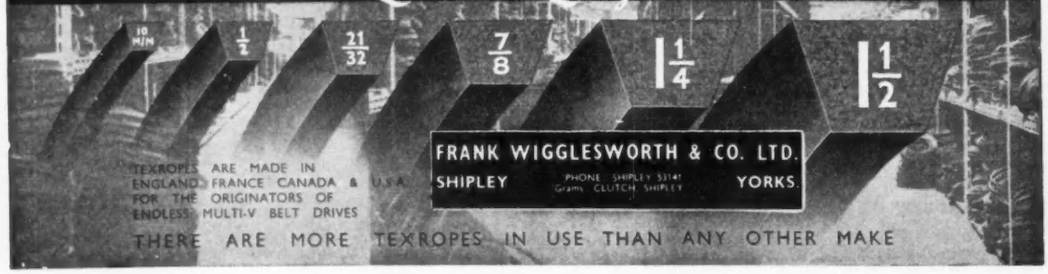

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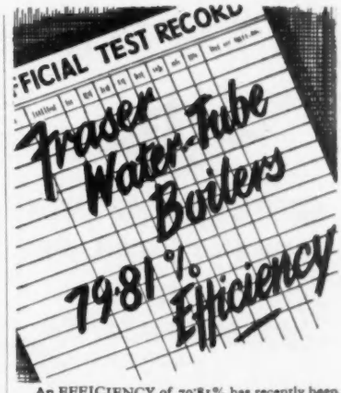

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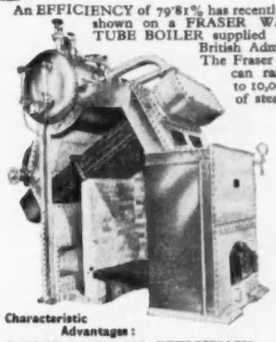

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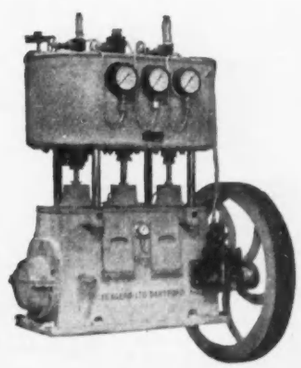

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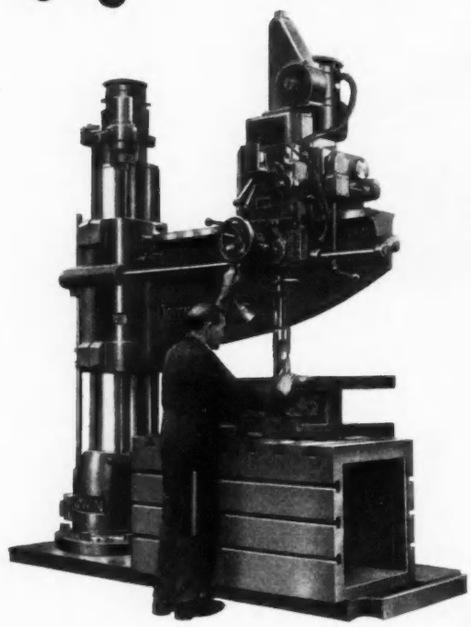

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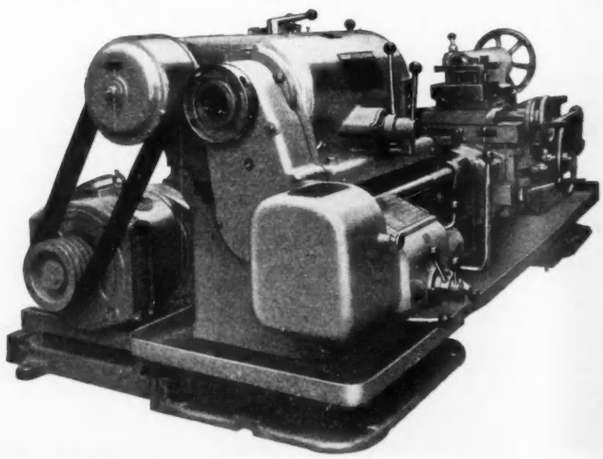

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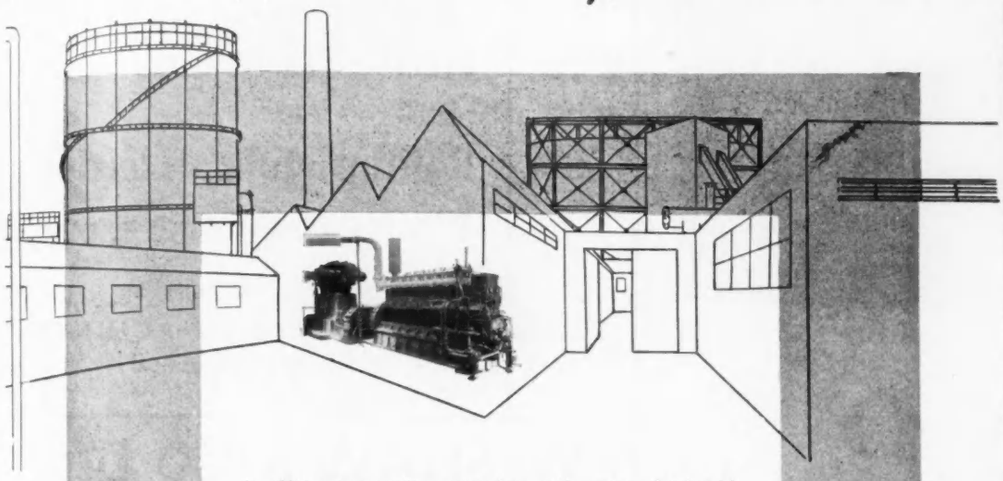

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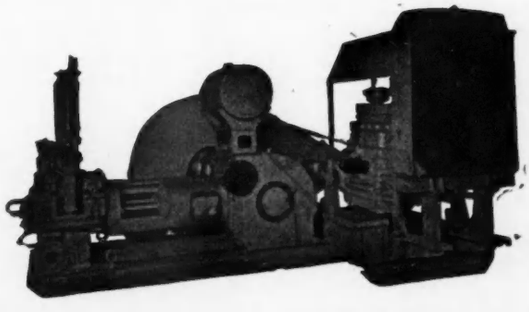

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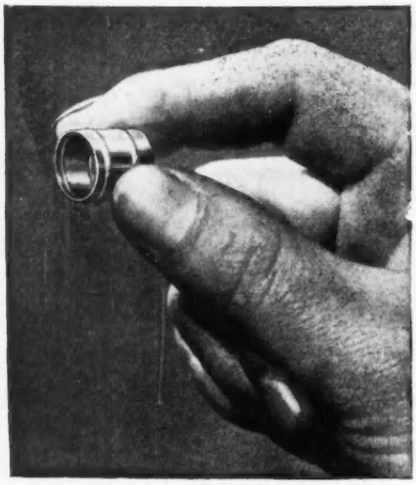

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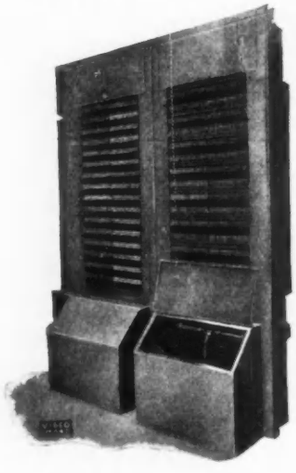

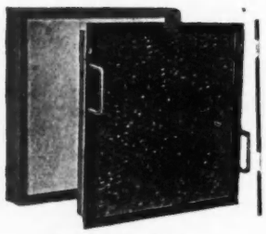

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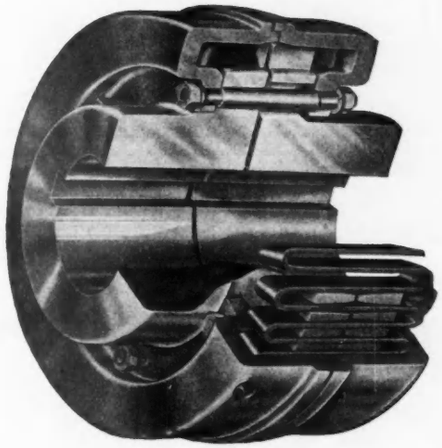

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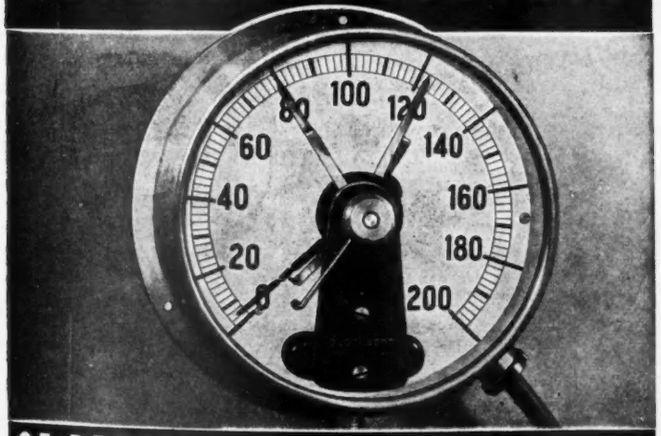

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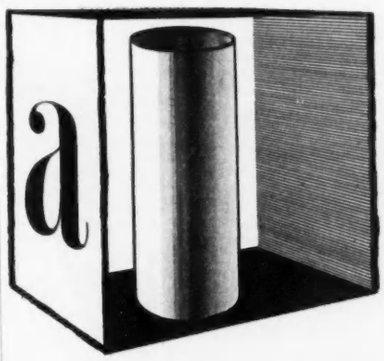
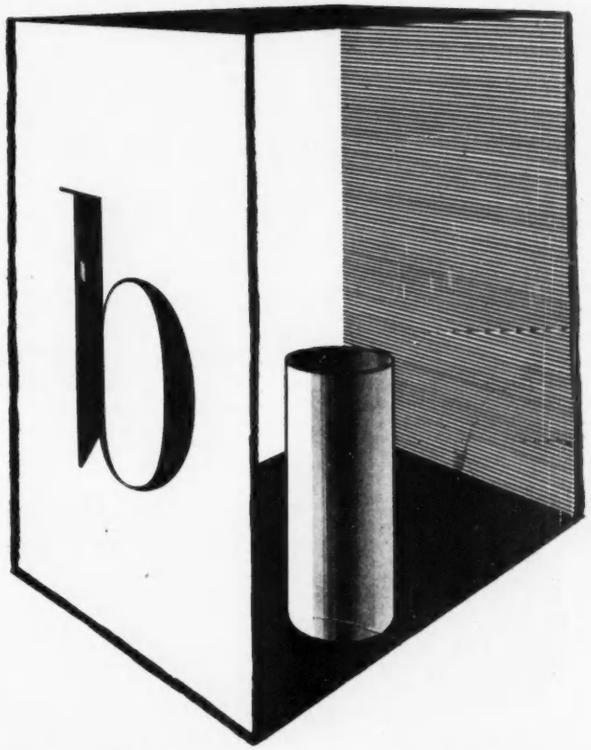


*which is biggest?**



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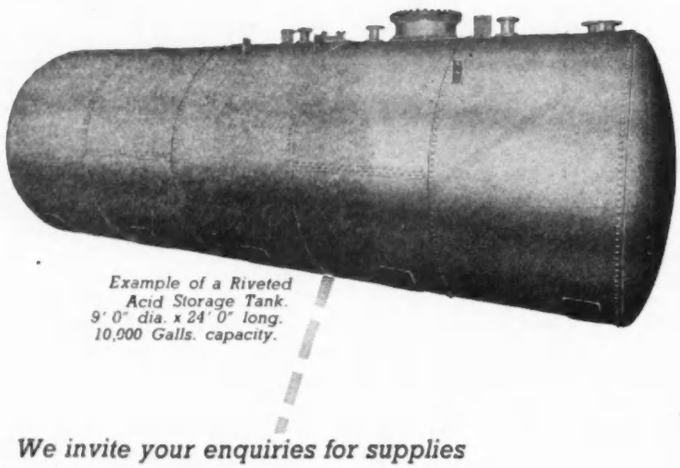

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CHIEF DESIGNER for new company manufacturing heat transfer equipment, Croydon area, Good prospects. Opportunity of becoming director. —Apply with particulars, BOX K 96, Offices of ENGINEERING.

TOOLROOM FOREMAN required for service Toolroom of large company engaged in light engineering in South Midlands. Applicants must have had at least 10 years practical experience excluding apprenticeship. First-class knowledge of grinding operations essential. Applicants with supervisory and administrative experience will receive preference. Established staff position carrying high salary, profit sharing and superannuation schemes.—Applications, giving full details to BOX J 970, Offices of ENGINEERING.

EXECUTIVE ENGINEER

required by
BRANDT & O'DELL,
CONSULTING ENGINEERS,
GROSVENOR GARDENS HOUSE,
VICTORIA, S.W.1.

Applicants to be not less than 35 years of age, Surveying, and Building in general. Capable of controlling and managing Field Teams and Drawing Offices. Excellent remuneration. Apply in writing in first instance giving full particulars and salary required. G 626

RESIDENT ENGINEER required on Tyneside for civil engineering and building work in shipyard reconstruction. Possibility of long term employment for man with good experience. Apply, stating age, qualifications and experience and salary required to BOX J 964, Offices of ENGINEERING.

COAL PREPARATION SALES MANAGER

Applications are invited in the Chesterfield Office of The Birtley Company Limited for the post of Coal Preparation Sales Manager. Intending applicants should already be in close contact with Divisional and Area levels of the N.C.B., and possess up-to-date experience in Coal Preparation. Salary according to suitability and qualifications. Applications should be addressed to :

THE SECRETARY,
THE BIRTLEY COMPANY LIMITED,
BIRTLEY, Co. DURHAM

stating age, qualifications and salary required. K 64

SENIOR PROJECT ENGINEERS

LOCKHEED HYDRAULIC BRAKE CO., LTD., LEAMINGTON SPA, have a number of vacancies for Senior Project Engineers.
Applicants should possess an engineering degree or be eligible for membership of a recognised engineering institution and have had about 5 years engineering experience preferably in the automobile field. In addition they must have drive, initiative, a flair for original design, and the ability to direct the requirements of development testing.
These are senior appointments and the commencing salary will be commensurate with experience and qualifications.
Applications, in strictest confidence, should give full details of qualifications, experience and positions held, with salary, to:—
PERSONNEL OFFICER,
LOCKHEED HYDRAULIC BRAKE CO., LTD.,
TACHBROOK ROAD, LEAMINGTON SPA. K 49

PILKINGTON BROTHERS LIMITED, who are the largest manufacturers of plate and sheet glass in the British Commonwealth and employ more than 20,000 persons, wish to appoint a
HEAD OF THEIR TECHNICAL DEVELOPMENT DEPARTMENT.
This is a new appointment necessitated by the large number of development projects in hand. It is intended that the man selected should take charge of the development of new processes and the radical improvement of existing ones. There are ample technical resources available and the Company spends large amounts on development work. Applicants must have a good Honours Degree in engineering, physics or chemistry. They must also have a flair for development work, and the enthusiasm to see a job through. Applications will be welcomed from men aged preferably 35/45, who have done at least five years development work in industry or at a University. The Company is prepared to offer a Service Agreement on an attractive salary to the right man. The Company operates contributory Superannuation and Widows Pension Funds. All applications will be treated confidentially and should be addressed to the GROUP PERSONNEL OFFICER, PILKINGTON BROTHERS LIMITED, THE GLASS WORKS, ST. HELENS, LANCASHIRE. J 956

A PUBLICITY MANAGER

is to be appointed by an important firm in the field of building and engineering materials in the Manchester area. He should have experience of technical advertising and publicity in an industrial concern and be conversant with the preparation and supervision of printed matter, exhibitions, editorials, etc. Initial salary dependent upon age and capabilities but not less than £800 p.a. with every prospect of progressive advancement.—BOX J 962, Offices of ENGINEERING.

DRAWING OFFICE CHECKER wanted for Machine Tool and Sheet Metal Machine Drawings.—F. J. EDWARDS LTD., 359, EUSTON ROAD, LONDON, N.W.1. K 142

PLANNING ENGINEER.

ALLEY & MACLELLAN (POLMADIE) LTD., GLASGOW, S.2, require the services of a fully qualified
PLANNING ENGINEER. He must have first class experience in modern production methods in medium/heavy machine shops and be capable of working on own initiative.
Applicants should have a good general education and preferably possess a National Certificate in either Mechanical or Production Engineering.
This is a key position in the organisation and for the right man will provide an excellent opportunity for promotion to a higher position in the company.
The post is superannuated after a trial period and carries a good commencing salary.
Reply in writing giving full particulars to the PERSONNEL OFFICER, ALLEY & MACLELLAN (POLMADIE) LTD., JESSIE STREET, GLASGOW, S.2. K 71

INTERNATIONAL AGENCY requires
BORING ENGINEER for Middle East to plan and direct the drilling and development of ground water supplies. Must be widely experienced in water well drilling and production development techniques, also operation and maintenance of modern deep well pumping installations. Must be able to draw up specifications of plant and equipment and to prepare programme estimates. Salary and allowances in accordance with qualifications and experience.—Apply in writing for application form to BOX K 161, Offices of ENGINEERING.

An excellent opportunity is offered to **YOUNG UNIVERSITY GRADUATES** to prepare themselves for responsible management appointments. The Advertisers are an industrial Company of standing and would consider applications from men up to 28 years of age who are alert and ambitious and willing to take responsibility. A salary up to £1000 per annum is offered and first rate prospects. Full details of qualifications and experience should be sent in confidence to BOX K 137, Offices of ENGINEERING.

SIR W. G. ARMSTRONG WHITWORTH AIRCRAFT LTD

ARMAMENTS DIVISION

1. DEPUTY TO CHIEF DYNAMICS ENGINEER

A vacancy exists for a Senior Engineer as a Deputy to the Chief Dynamics Engineer of a major organisation in the Guided Weapons Industry.
Applicants must have completed an apprenticeship with a well-known firm and should have a minimum of five years' experience on Research or Development work; preferably with some experience of vibration or climatic testing.
Qualifications should include an Honours degree in Electrical or Mechanical Engineering, and some experience in taking charge of technical personnel is essential.
The salary scale will be commensurate with the high degree of responsibility associated with this post.

2. TECHNICIANS

Two Technicians are required for Dynamic and Climatic investigations which cover a wide variety of problems.
The essential qualifications required are a degree in Electrical or Mechanical Engineering or its equivalent, and one to three years' practical experience in this type of work.
These posts offer an interesting career, together with attractive salaries and with good opportunities for advancement.
Excellent working conditions and amenities are provided, and an attractive superannuation scheme is in operation.

All replies should be addressed to :—
TECHNICAL APPOINTMENTS OFFICER,
SIR W. G. ARMSTRONG WHITWORTH AIRCRAFT LTD.,
BAGINTON, NR. COVENTRY,
Quoting reference ARM/TAO.
K 135

Classified Advertisements continued on Page 106

BRITISH CELLOPHANE LIMITED, BRIDGWATER, SOMERSET, seeks

SENIOR AND JUNIOR DRAUGHTSMEN, for both **PERMANENT AND TEMPORARY** appointments, for work on machine design and chemical plant layout. Applicants should possess at least O.N.C. and have had three years' shop experience. Five-day week, Pensions Fund scheme for permanent appointments. Ref. No. E44.Eg.

THE TEMPORARY appointments are for a period of approximately two years' duration, subject to three months' notice and include generous subsistence allowances, and periodic home return rail fares.

ESTIMATOR (PERMANENT). Applicants should have served an engineering apprenticeship and have technical education up to O.N.C. standard. The work involved will be on the preparation of material and labour specifications in connection with engineering work, electrical estimating experience an advantage. Ref. No. E46.Eg.

ASSISTANT ENGINEER, AGE 23/30 (PERMANENT). Applicants should have an honours degree in mechanical engineering and have had some practical works experience. The duties will be on development, improvement and maintenance of chemical and other plant. Ref. No. E45.Eg.

ASSISTANT ENGINEER, AGE 25/50 (PERMANENT). Applicants should have a university degree and have works experience, or be an A.M.I.Mech.E. The duties will be on development, improvement and maintenance of plastic films extrusion plant and ancillary equipment. Ref. No. R43.Eg.

Write to the PERSONNEL OFFICER, stating full particulars and salary required, and quote Ref. Nos. as indicated. J 912

SIMON-CARVES, MINING DIVISION, invite applications from

EXPERIENCED ENGINEERS capable of supervising the complete erection and commissioning of all types of colliery winding and surface equipment, to fill posts as Resident Site Engineers on large scale Colliery construction and reconstruction. Candidates must be qualified electrical and mechanical engineers with previous erection experience. Salary according to experience and qualifications plus adequate out allowance.—Apply stating age, experience, previous employers and quoting reference BU.4 to CONTRACT LABOUR OFFICE, SIMON-CARVES, LTD., CHEADLE HEATH, STOCKPORT, CHESHIRE. K 33

Expanding engineering company near Lake District offers good scope to

A DRAUGHTSMAN prepared to use initiative in the design and development of either coal mining machinery or earth moving machinery. Previous experience of these kinds of machinery is desirable but experience of medium or heavy general engineering may be acceptable. Good conditions. Pension scheme. Assistance with housing.—Apply DISTINGTON ENGINEERING COMPANY LIMITED, P.O. BOX 8, WORKINGTON, CUMBERLAND. K 13

ENGINEER—AGE 30-35, to manage a small works with good prospects of expansion. Must have experience of training and managing men, ingenuity, a tidy mind and ambition, with a liking for tackling production problems. Starting salary £1200 to £1500. District South Yorkshire. Apply by letter to the SECRETARY, SAMUEL OSBORN & CO., LIMITED, P.O. BOX No. 1, SHEFFIELD. K 80

TANGYES LIMITED.

GENERAL WORKS MANAGER. The Company wish to appoint a Senior Executive Engineer, who, having proved himself suitable, will be capable, after a period, of taking over the general control of the Works including large iron foundry on the retirement of the present General Works Manager. Applicants should have wide experience of modern machining and assembly methods, Planning and Time Study for both batch and one-off production and labour control. Iron Foundry experience an advantage. The position offers excellent prospects. Pension Scheme available. Applications, which will be considered in strict confidence, must give details of Technical and practical training, past employment, age, etc., to be addressed to the ASSISTANT MANAGING DIRECTOR (ADMIN.) TANGYES LIMITED, CORNWALL WORKS, SMETHWICK, BIRMINGHAM. K 26

MECHANICAL ENGINEERING DRAUGHTSNEN
and
CIVIL ENGINEERING DRAUGHTSMEN

IMPERIAL CHEMICAL INDUSTRIES LIMITED BILLINGHAM DIVISION

offer attractive salaries in respect of several vacancies for each of the above classes of draughtsmen. Candidates must possess as a minimum qualification, the appropriate Higher National Certificate or its equivalent. Participation in Staff Pension Fund and Profit-Sharing Scheme. Financial assistance towards removal expenses available for married men. Without commitment, write for Application Form to the STAFF MANAGER, IMPERIAL CHEMICAL INDUSTRIES LIMITED, BILLINGHAM DIVISION, BILLINGHAM, CO. DURHAM, quoting reference U.12. G 633

ENGINEER.

Experienced engineer required for a senior post on a large copper mine in Northern Rhodesia. Applicants should be between 30 and 40 years of age and should hold a B.Sc. Degree in Engineering or equivalent professional qualifications.

They should have had considerable practical experience, preferably in Mechanical Engineering in the mining field although experience in other branches of engineering will be considered.

Previous experience in an administrative or executive capacity is essential. Basic salary will depend on experience and qualifications. There is also a cost of living allowance currently £70 per annum, a bonus based on the prosperity of the industry and which is at present in excess of 70 per cent. of basic salary and a pension and life assurance scheme. A house with basic essential furniture is available at a nominal rental. Leave is at the rate of 55 days per annum and can be accumulated for three years. Free passages to Northern Rhodesia for successful applicant and family are provided. Reply giving details of age, experience, marital status, together with copies of testimonials, and a recent photograph to R.3 MINES EMPLOYMENT DEPARTMENT, SELECTION TRUST BUILDING, MASON'S AVENUE, COLEMAN STREET, E.C.2. J 974

FIRST CLASS ENGINEER

Required,
must be experienced in Steel Rod and Wire Mill Practice.

Degree in Mechanical Engineering or equivalent.

This is a senior Staff appointment ideally suited to man 30/40 years of age requiring interesting, progressive and permanent post carrying a four-figure salary. Applications in writing giving details of age, education, experience, salary required, and when available to:

RICHARD HILL LIMITED,
NEWPORT WIRE & ROLLING MILLS,
MIDDLESBROUGH.

K 28

JOHN LAING AND SON LIMITED

invite applications for the following technical staff vacancies resulting from promotion and expansion at the Research and Development Centre, Boreham Wood, Herts.

CHIEF MECHANICAL DESIGN ENGINEER.

In charge of Mechanical and Electrical Design Department. Preferably Chartered Mechanical Engineer, and an additional electrical qualification desirable. Adequate general engineering experience with specific design work on medium heavy plant and equipment. Age 30-50. Considerable opportunity for original design in a very wide field, together with general consultative services to the Company and its subsidiaries. Applicants must be adaptable and ready to tackle a wide variety of problems.

SENIOR MECHANICAL DESIGN ENGINEERS.

Qualifications and experience similar to the above though less advanced. Age 28-50.

ASSISTANT DESIGN ENGINEERS AND DRAUGHTSMEN.

Experience of mechanical design and detailing is desirable, but applications will be welcomed from graduates and those seeking to qualify professionally. Age 21 upwards.

The above posts are on a permanent basis, and are progressive and pensionable. The work is varied and interesting and holds attractive prospects in an expanding field. Five-day week.

Canteen and Sports Club facilities.

Apply in writing stating age, qualifications, and salary expected, to:—PERSONNEL MANAGER (M.18), JOHN LAING & SON LIMITED, BUILDING AND CIVIL ENGINEERING CONTRACTORS, LONDON, N.W.7. J 765

DEPUTY CHIEF ENGINEER

THE CHAIRMAN of a large organisation engaged in LIGHT ENGINEERING covering diverse fields wishes to appoint a

DEPUTY CHIEF ENGINEER.

To a successful Deputy there will be prospects of early promotion to **CHIEF ENGINEER** and **DIRECTOR.** The **DEPUTY CHIEF ENGINEER** will be required to lead and co-ordinate a number of specialist engineering teams, each of outstanding ability in its own sphere.

Essential qualifications are an honours degree in engineering or physics, membership of one of the leading professional institutions and high standing in industry, academic work or Government service. If now engaged academically, or in Government service, it is essential that the applicant should have obtained good industrial experience at an earlier date.

The appointment is suitable only for a man with wide engineering interests and knowledge, creative capacity, judgment, and enthusiasm, and ability to organise, lead, work with, and inspire scientists and engineers. Marked technological ability in any narrow specialised field will not be of great advantage. Age range 40/45 years but applicants with extraordinary qualifications outside this age range will be considered.

Applications will be treated in the strictest confidence by the Chairman and no communication will be made to any other person without the applicant's permission.

Total emoluments will not be less than £5000 per annum.

Applications in writing, marking envelope "DCE," to 146, LEADENHALL STREET, LONDON, E.C.3. K 130

NEW RESEARCH LABORATORY

IMPORTANT APPOINTMENTS

Powers-Samas Accounting Machines, Ltd. (one of the Vickers Group of Companies) is expanding the resources of its Research Division for the development of electronic data processing equipment, punched-card machines and allied devices. A new Research Laboratory is under construction at Caterham, Surrey—and until its completion the staff appointed will work at existing establishments in Croydon and Crayford, Kent.

The appointments offered provide scope for both senior and junior staff. Salaries will be competitive and in accordance with qualifications and experience. Applications are invited from:—

1. Honours graduates in physics or engineering for a wide range of research and development work on electronic computors and associated equipment.
2. Engineers with Higher National Certificate for development and design work on electronic computors and associated equipment.
3. Juniors possessing evidence of the necessary scholastic and technical ability who wish to continue with studies for higher qualifications.

Applications, with details of previous experience and qualifications, should be sent to THE PERSONNEL MANAGER, POWERS-SAMAS ACCOUNTING MACHINES, LTD., CROYDON. G 628

REQUIRED.

TWO ASSISTANTS IN DESIGNS OFFICE of newly-formed and expanding company engaged in nuclear engineering. Drawing office experience essential. Formal qualifications are secondary to experience and a flair for mechanical design in the fields of light and medium engineering. Applicants should be adventurous in outlook and prepared to work as member of small enthusiastic team. Excellent prospects. Those interested should write to BOX K 82, Offices of ENGINEERING, giving a brief outline of experience and salary required. Location of work, 15 minutes from London Bridge (S.R.).

AN ASSISTANT ELECTRICAL ENGINEER is required for investigating the electrical problems encountered in an integrated Iron and Steel Works possessing its own generation and distribution system.

Applicants should be graduates between 23 and 30 years of age.

Applications to:—
THE CHIEF ENGINEER,
WORKINGTON IRON & STEEL COMPANY,
MOSS BAY, WORKINGTON, CUMBERLAND.
Please mark your application "PERSONAL." J 986

A Public Company require the services of an **ENGINEER GRADUATE.** The situation is the first of its kind, and the work on which the successful applicant would be engaged would be very varied. Qualities such as personality, versatility and adaptability against a broad scientific education with some practical experience would meet our requirements.—Apply BOX J 928, Offices of ENGINEERING.

SALES ENGINEER (TECHNICAL) required immediately by British affiliate of an American company to operate in the Birmingham area; candidates should be capable of discussing technical problems in association with various processes met with in the fields of metal working, electronics and industrial lubrication; sound technical background up to B.Sc. standard, progressive outlook, proved sales ability and good appearance are essential requirements: the position offers scope for advancement within the organisation and provides interesting technical sales work. Write, giving full personal details and industrial knowledge, also state salary required and whether owner of a car, to ACHESON COLLOIDS LTD., 18 PALL MALL, LONDON, S.W.1. K 52

Opportunities in
LOW TEMPERATURE ENGINEERING.
Applications are invited for appointment as

DEVELOPMENT ENGINEERS

to undertake interesting projects, involving thermodynamics, heat transfer distillation, and covering the technical design and operation of plants. The projects are concerned with the production and distribution of oxygen, nitrogen and argon as gases or liquids.

Applicants should hold an Honours Degree.

For people joining the Company from outside the North London area, it is of interest that the Works is within easy travelling distance of North London residential areas, verging on the Green Belt of Middlesex and Hertfordshire, and on Epping Forest. FULL ASSISTANCE TOWARD THE PURCHASE OF HOUSES WILL BE GIVEN TO SELECTED APPLICANTS AND REMOVAL AND LEGAL EXPENSES PAID.

Applications, giving fullest possible information of qualifications and experience to :—

The Personnel Manager,
BRITISH OXYGEN ENGINEERING, LTD.,
ANGEL ROAD, UPPER EDMONTON,
LONDON, N.18. J 846

HAWTHORN LESLIE (ENGINEERS) LTD.,

ST. PETER'S WORKS, NEWCASTLE - UPON - TYNE.

HAVE THE FOLLOWING VACANCIES IN THE MARINE TURBINE SECTION OF THEIR DRAWING OFFICE :

SENIOR DRAUGHTSMAN

to take full charge of the turbine section of the Drawing Office, responsible only to the Chief Draughtsman—applicant must be fully experienced in the design and details of modern marine turbine propulsion machinery. Position would carry staff status.

DRAUGHTSMEN

previous experience in turbine detail work an advantage, but not essential.

Applicants should write to:—

THE CHIEF DRAUGHTSMAN

stating age, and full particulars of their technical and practical training and experience.

Starting salary according to qualifications and subsequent advancement on merit. Permanent positions. Staff Pension Scheme. K 11

ENGINEER, AGE 25 35, required by progressive engineering company handling aluminium products. Good education and thorough practical experience essential with preferably Higher National Certificate or similar qualification. Excellent prospects for man with drive and initiative who has had good technical training. Apply in confidence to LABOUR MANAGER, ENFIELD ROLLING MILLS (ALUMINIUM, LTD., BRIMSDOWN, ENFIELD, MIDDLESEX, giving full details and salary required. K 139

WM. CORY & SON LTD., ENGINEERING DEPARTMENT, ERITH, KENT, require the following staff:—

DRAUGHTSMAN.
JUNIOR DRAUGHTSMAN.

Applicants preferred with experience (but not essential) in Coal Discharging Plant and Equipment, comprising Cranes, Tugs and Barges, and General Engineering on the River Thames. Pension Scheme.—Apply in writing, stating Age, Qualifications, Experience and Salary required. K 63

A well-known Organisation with world-wide interests wishes to recruit a

YOUNG QUALIFIED MECHANICAL ENGINEER, age 23/30 for appointment as an Assistant Engineer within their Production Division. The successful applicant will become a member of a management team and should be capable of accepting a high degree of responsibility within 3/4 years. This is an attractive opportunity for the right man. The Organisation is expanding and its product is an interesting one.—Reply, stating full particulars of age, qualifications and experience to BOX K 62, Offices of ENGINEERING.

NEW RESEARCH LABORATORY

IMPORTANT APPOINTMENTS FOR ENGINEERS.

POWERS-SAMAS ACCOUNTING MACHINES, LTD. (one of the Vickers Group of Companies) is expanding the resources of its Research Division for the development of electronic data processing equipment, punched-card machines and allied devices. A new Research Laboratory is under construction at Caterham, Surrey—and until its completion the staff appointed will work at existing establishments in Croydon and Crayford, Kent.

Appointments, which will be at competitive salaries, and in accordance with qualifications and experience, are offered to:—

1. Engineers with graduate or equivalent qualifications for research and development work on small complex mechanisms associated with punched card accounting systems.

2. Engineers with a sound technical background and ability to analyse complex mechanisms and to effect practical and economic improvement.

Applications, with details of experience and qualifications, should be sent to THE PERSONNEL MANAGER, POWERS-SAMAS ACCOUNTING MACHINES, LTD., CROYDON. G 629

AFRICAN EXPLOSIVES AND CHEMICAL INDUSTRIES LIMITED

Applications are invited for appointments at the Factories and Research and Consulting Engineer's Departments of the above mentioned Company in the Union of South Africa.

The Company's three main Union factories are located near Johannesburg, Cape Town and Durban respectively.

Vacancies exist for :—

(1) **PLANT AND LABORATORY CHEMISTS** with Chemistry or Chemical Engineering qualifications.

(2) **RESEARCH CHEMISTS** with post-graduate qualifications in Chemistry or Physics.

(3) **MECHANICAL AND ELECTRICAL ENGINEERS,** preferably with not less than two years experience since graduation

(4) **INSTRUMENT ENGINEERS** with Electrical (Light Current) or Chemical Engineering qualifications and maintenance and/or design experience in industrial instrumentation.

Further information and application forms can be obtained from H. W. AHRENS, AFRICAN EXPLOSIVES & CHEMICAL INDUSTRIES LIMITED, IMPERIAL CHEMICAL HOUSE, MILLBANK, LONDON, S.W.1. G 634

MECHANICAL MAINTENANCE ENGINEER required for a medium-sized plant in Yorkshire. Experience of preventative maintenance schemes and installation of plant desirable. Applicants please state age, experience, qualifications, and salary required.—BOX K 103, Offices of ENGINEERING.

SENIOR DEVELOPMENT ENGINEER, responsible to Chief Engineer, for Technical Development and Experimental work on heavy Crawler Tractors and auxiliary equipment for use in earth-moving and agricultural purposes. Age preferably between 30 and 40 years, with qualifications, degree in mechanical engineering or equivalent, and/or corporate membership of professional Institution. Ability to control staff and organise testing programmes and interpretation of design problems. Staff appointment. Contributory Pension and free Life Assurance Scheme operating.—Write in first instance giving full details of qualifications, experience, age and salary required, to PERSONNEL MANAGER, JOHN FOWLER & CO. (LEEDS), LTD., LEATHLEY ROAD, HUNSLET, LEEDS, 10. K 126

HYDRAULICS. Glasgow firm specialising in Centrifugal Pumps of all sizes and types has vacancies for

SEVERAL YOUNG MEN INTERESTED IN HYDRAULIC DESIGN AND DEVELOPMENT. Candidates should have training to University degree or Technical College diploma standard, should have served an Engineering Apprenticeship and should have completed, or be exempt from, National Service. A.M.I.Mech.E. is an advantage.

Good salary depending on qualifications. Pension Scheme available. These openings offer excellent opportunities for advancement as experience is gained to a man with initiative able to translate his ideas into practical form.

Applications stating training, experience and salary expected, should be addressed in writing to 1410 WM. PORTEOUS & CO., GLASGOW. K 104

SENIOR ENGINEER required to assume overall responsibility for mechanical engineers in a large electronic engineering laboratory. Applicants must have experience of small mechanisms, chassis, and structural work and be fully aware of design requirements for mass production of high grade equipment. A.M.I.Mech.E. or equivalent. Age 30 to 40 years.—Please reply, in confidence, giving full details to BOX K 136, Offices of ENGINEERING.

IMPERIAL CHEMICAL INDUSTRIES LIMITED,
METALS DIVISION,
Vacancies exist for

ENGINEERS

Senior plant design Engineers to co-ordinate the design and development of special-purpose plant, services and facilities in connection with work on the Guided Weapon project. Qualifications necessary are a university degree in Engineering or its equivalent and several years of this sort of practical experience,
and
Junior Engineers to assist in the running of engineering workshops, the organising of plant maintenance and the placing of sub-contracts in connection with work on the Guided Weapon project. Qualifications necessary are H.N.C. or equivalent and several years of practical engineering experience in this field.

The posts afford interesting work in pleasant surroundings with good salaries and conditions of employment. After joining the staff, married men will receive a reasonable refund of removal (including travelling) expenses, and facilities are available in approved cases for loans for house purchase, and advancement of legal charges.

Applications should be addressed to G.S.M., SUMMERFIELD RESEARCH STATION, KIDDERMINSTER, WORCS. K 125

BRITISH PETROLEUM COMPANY LIMITED, has immediate vacancies for

CHEMISTS, CHEMICAL ENGINEERS AND MECHANICAL ENGINEERS for work in their United Kingdom Refineries and at their Research Station at Sunbury-on-Thames. Applications are invited from men with first or second class honours degrees or equivalent qualifications and who have fulfilled National Service obligations. Previous industrial experience desirable, but not essential. Age, preferably not above 33. Salaries within the range £650 to £1300, according to qualifications and experience. Excellent working conditions. Non-contributory Pension Scheme.—Write, giving full details QUOTING H.3297 to BOX 7913, c/o 191, GRESHAM HOUSE, E.C.2. G 565

DRAUGHTSMEN, Senior and Junior, with general engineering experience are required for a large Plate Glass Works. The work includes plant layout, both heavy and light, design of special purpose machines, provision of building and services and the modernisation of existing machinery and plant.

The office is of medium size with about thirty persons, so that each and all get a good variety of jobs. There are opportunities for promotion for those who show an interest and aptitude for production work.

Write giving age, qualifications and experience to the CHIEF ENGINEER, PILKINGTON BROTHERS, LIMITED, COWLEY HILL WORKS, ST. HELENS, LANCASHIRE. K 107

PHILIPS ELECTRICAL, Resistance Welding Department.

AN ELECTRICAL ENGINEER, H.N.C. Minimum qualifications, some industrial experience, preferably on Electronic Instruments, is required for work on Electronic Timers. Salary according to qualifications and experience.—Apply PERSONNEL OFFICER, PHILIPS BALHAM WORKS, LTD., 45, NIGHTINGALE LANE, LONDON, S.W.12. K 117

Well-known Midland aero engine company requires **MECHANICAL ENGINEERING DESIGNERS AND DRAUGHTSMEN** to join teams on various aspects of engine construction. Initial salary, £650-£1000 per annum. Owing to expansion in new drawing offices, with excellent working conditions departments will offer good prospects to men with initiative. Sickness benefits for families and pension fund. Full details quoting Reference AD/2, to BOX G 632, Offices of ENGINEERING.

POWER ENGINEER required by International Group for Service on oilfields in the MIDDLE EAST, age 35/45 years. Applicants should have university degree in general or electrical engineering, or equivalent and should preferably have had previous experience of power supply services on oilfields. In any case, should have had extensive experience in the operation and maintenance of steam boilers, water softening plant, boiler water treatment, power generating plant and auxiliary equipment, gas combustion turbines, diesel and gas engines; the design, construction and maintenance of E.H.T. overhead networks, L.T. distribution networks, and associated transformers and switchgear; electric motors; and the installation, operation and maintenance of flameproof equipment for oil installations.

Two-year tour in the first instance and substantial salary, payable also while on leave. Married accommodation and free family passages available. —Write, giving brief details of age, experience, etc., for application form, to BOX E.G.587, c/o 191, GRESHAM HOUSE, E.C.2. K 90

CHIEF PLANNING ENGINEER required to initiate and supervise the production methods of small internal-combustion engines.

He must have had considerable experience of methods used on large scale production in this or a similar field. Salary commensurate with qualifications. Pleasant working conditions. Attractive Pension Scheme.

Apply to CHIEF PERSONNEL OFFICER, PETTERS LIMITED, STAINES, MIDDLESEX. K 93

ENGINEERING SALESMAN wanted, with experience of expansion joints, pipe work, valves, etc., in Chemical, Petroleum, Steam and Diesel applications. Car owner preferred. Engineering background and selling ability vital. Ground floor opportunity for right man.—Write BOX K 98, Offices of ENGINEERING.

ENGINEERING DRAUGHTSMEN (male or female) required for large Sheet Glass Works. Experience in Works Maintenance, Building or Mechanical Design would be an advantage. The positions are pensionable and progressive.—Applications stating qualifications, age and experience, should be addressed to the CHIEF ENGINEER, PILKINGTON BROTHERS, LIMITED, SHEET WORKS, ST. HELENS, LANCASHIRE. K 106

MECHANICAL ENGINEERING DRAUGHTSMEN required with training in Maintenance, Building and Mechanical problems. A knowledge of machine design would be an advantage. The positions are pensionable and progressive.—Applications stating qualifications, age and previous experience should be addressed to the WORKS PERSONNEL OFFICER, PILKINGTON BROTHERS, LIMITED, RAVENHEAD WORKS, ST. HELENS, LANCASHIRE. K 108

BRUSH ELECTRICAL ENGINEERING CO., LTD., LOUGHBOROUGH, LEICS, has a vacancy for a

DESIGN AND DEVELOPMENT ENGINEER in their Steam Turbine Department. Duties will involve Thermo-dynamic and Mechanical Design of turbine internals. Applicants should preferably hold an Engineering Degree but those with equivalent qualifications will be considered. Conditions include good salary and non-contributory staff assurance scheme.—Please reply in confidence to CHIEF PERSONNEL OFFICER. K 109

SALES ENGINEER. British Company require young man with good general knowledge of engineering to assist the Manager of the Department handling various mechanical and electrical engineering Agencies in Khartoum, Sudan. Excellent opportunity for keen and capable man. Accommodation available; free air passages; home leave; kit allowance; pension scheme.—Write BOX JA/125, c/o 95, BISHOPSGATE, E.C.2. K 114

Are you looking for interesting and varied work connected with Design, Development and Testing of a wide variety of new pieces of equipment for mechanical handling in Collieries and for Railway Signalling? We have vacancies for young men with ideas to work on mechanical, pneumatic and/or Electro-mechanical projects.

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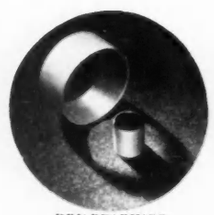

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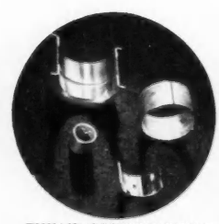

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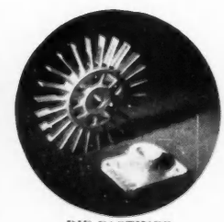

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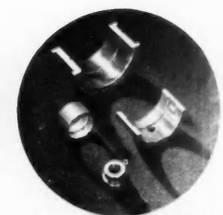

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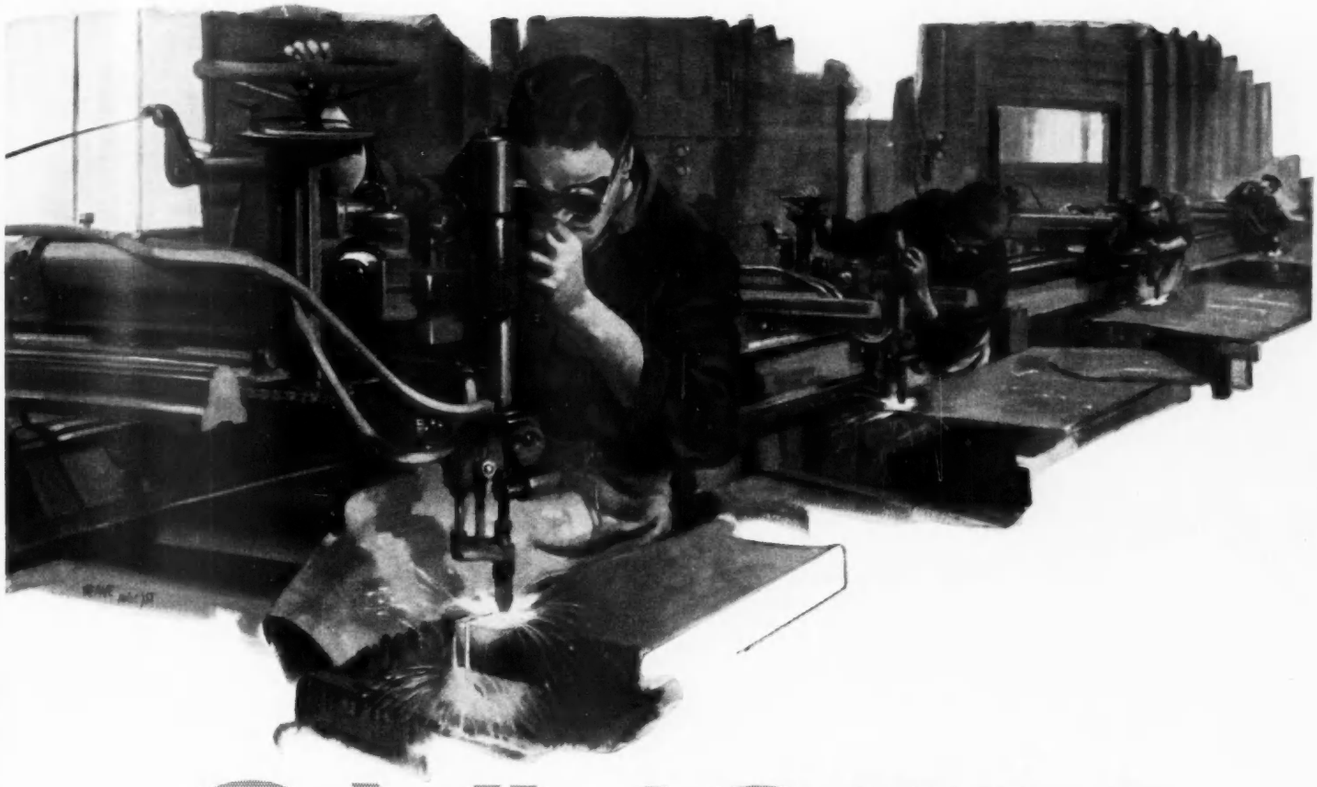

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